The NATIONAL GEOGRAPHIC MAGAZINE

Vol. XVI OCTOBER, 1905 No. 10

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XUM

THE NATIONAL GEOGRAPHIC MAGAZINE

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NOTE.

The Profile is taken on the Axis of the Canal.

The elevations of the original surface are taken from the lithographed Geological profile, scale xxxx furnished by the New Panama Canal Co. and prepared from data of the Old Company.

The elevations of the present surface on the Atlantic Ocean Level and in the Culebra Cut are from Cross Sections made by the Commission in February, 1900. The additional excavation in the Culebra Cut, not on the axis of the Canal, is shown by the broken line.

The elevations of the present surface of other parts of the Canal line are from a Profile, scale xxxx published by the New Panama Canal Co. in 1899.

9° 30′ — 79° 40′

Horizontal Scale xx.xxx

Vertical Scale xx.xxx

COLON · Monkey Hill · Mindi · GATUN · Tiger Hill · Dos Hermanos · Palo Horqueta · Palo Matias · Ahorca Lagarto · Vamos Vamos · Peña Blanca · Bohio Locks · Frijoles · TAVERNILLA · SAN PABLO · Memei · Juan Grande · GORGONA · MATACHIN · OBISPO · Obispo Guard Gate M 30.77 · Las Cascades

ATLANTIC OCEAN

Río Mindi · Río Chagres · Río Gatun · Río Chagres · Río Obispo · Río Obispo

Mean Ocean Level 0

Bottom of Canal -45

High Water Level +90

Low Water Level +70

Bottom of Canal -47

Atlantic Ocean Level: Length 16.81 Miles

Summit Level: Length 21.52 Miles

Heights from Mean Ocean level — Original surface / Present surface

Miles 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

79° 50′

9° 30′

OCEAN SEA

Río Grande

S. Alejó

I. de Naranjas

Zaragoza

I. del Muerto

pta Est

AS MINAS

Río Ulano

VARIATION

XUM

9°30′ 79°40′ 9°20 79°30′

Horizontal Scale
Vertical Scale

Peña Blanca · Bohio Locks · Frijoles · TAVERNILLA · SAN PABLO · Memei · Juan Grande · GORGONA · MATACHIN · OBISPO · Obispo Guard Gate · Las Cascades · EMPERADOR · CULEBRA · PARAISO · Pedro Miguel · Pedro Miguel Locks · Miraflores · Miraflores Lock · Corozal · Las Boca · PANAMA

Río Chagres · Río Obispo · Río Grande

Summit Level : Length 21.52 Miles

Pacific Ocean Level : Length 8.53 Miles

PACIFIC OCEAN

Río Chico · Río Fed.

El Aguila · Pequeni · San Juan · Chagres · Dos Bocas · El Vigia · Las Campanas · Río Chagres · Suggested Dam · ALHAJUELA

VARIATION 4° 55 EAST

SANTA BARBARA SEPT. 1900

XUM

MAP

SHOWING LOCATION OF PAN

AS RECOMMENDED BY THE ISTHMIAN CANAL COMMISS

Scale $\frac{1}{100,000}$

Statute Miles

1 3/4 1/2 1/4 0 1 2 3 4 5 6

Nautical Miles

1 3/4 1/2 1/4 0 1 2 3 4 5 6

Kilometers

1000 500 0 1 2 3 4 5 6 7 8 9 10 11

9°20 79°30 9°10

PACIFIC OCEAN

Rio Grande Rio Grande Rio Grande

Corozal

La Boca

PANAMA

Pacific Ocean Level : Length 8.53 Miles

42 43 44 45 46 47 48 49 Miles

1 368 M A 14°17' A 30°48' 3564 MILES
R 19.672 R 11.483
D 0.872 D 1.168 M

Rio Chagres

Rio Frd.

Cano Banita

Rio Indio

El Aguila

Pequeni

Qda San Juan

Qda Ironquillo

San Juan

Chagres

Dos Bocas

Qda del

Rio de la Puente

El Vigia

Las Campanas

Rio Chagres

Qda Azota Caballo

Qda Marcelito

Suggested Dam

Rio del Madero

ALHAJUELA

Santa Barbara

Old paved road from Panama to

Rio Chilibrilla

Rio Mariprieta

Rio Lajas

Rio Mano Henriquez

105

XUM

MAP

SHOWING LOCATION OF PANAMA CANAL

AS RECOMMENDED BY THE ISTHMIAN CANAL COMMISSION OF 1899-1902.

Scale $\frac{1}{100,000}$

Statute Miles

1 3/4 1/2 1/4 0 1 2 3 4 5 6 7 8 9

Nautical Miles

1 3/4 1/2 1/4 0 1 2 3 4 5 6 7 8 9

Kilometers

1000 500 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

9° 10′

79° 20′

79° 20′

9° 00′

Barbara

Old

paved

road

from

Panama

to

Rio

Chagres

Rio

Lajas

Rio

Juan

Diaz

Rio

Las

Cascadas

Rio

Trinidad

Rio

Grande

Rio

Caimito

Rio

Pedro

Miguel

Rio

Obispo

Rio

Mindi

Rio

Curundu

Rio

Abajo

Rio

Grande

Rio

Maria

Henriquez

Rio

Matachin

Rio

Macapriata

Rio

Gigante

Rio

Frijoles

Rio

Gatun

Rio

Trinidad

Rio

Boqueron

Rio

Caimito

Rio

Pedro

Miguel

Rio

Obispo

Rio

Mindi

Rio

Curundu

Rio

Abajo

Rio

Grande

Rio

Maria

Henriquez

Rio

Matachin

Rio

Macapriata

Rio

Gigante

Rio

Frijoles

Rio

Gatun

Rio

Boqueron

Rio

Chagres

Rio

Lajas

Rio

Juan

Diaz

Las

Cascadas

Rio

Grande

XUM

OCEAN

CARIBBEAN

SEA

9°
30

80°
00

I. de Naranjas

I. del Muerto

Pta Est

S. Alejo

Rio Grande

Zaragoza

BAY OF LAS MINAS

Pta Hala Remo

Pta Caño Principal

Rio Cara Sola

BAY OF MANZANILLO

Manzanillo Island

Boca Grande

COLON

Lighthouse

Fathoms

LIMON BAY

Pta Toro

Lighthouse

Playa de Flor

Rio del Puerto Escondido

Marajal

Monkey Hill

GATUNCILLO DIVERSION

Rio Ulano

Sucio

BAY DEL MUERTO

Rio Ensenada

Rio Manzanillo Concha

Santa Rita

Rio Agua Clara

Rio Gatun

Qda. Francisco

Rio Agua Sucia

Qda la Chacarita

C. Chiquito

La Soledad

QUEBRANCHA

Rio Chimilla

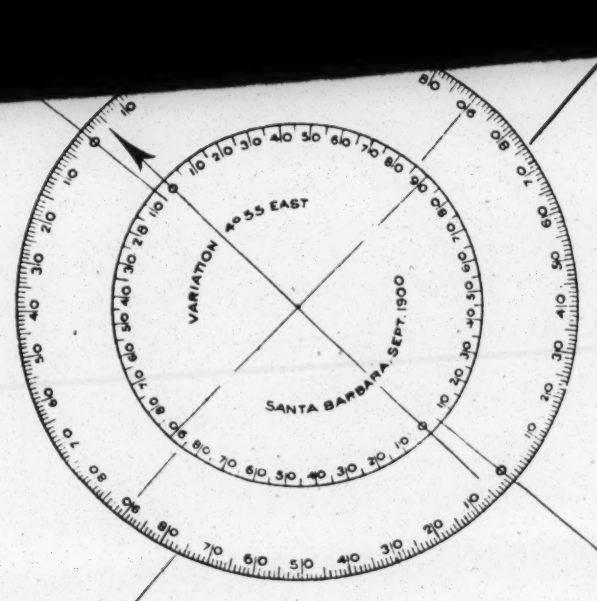
Rio Gatun

Qda Monte Viscoso

AGARTO

VARIATION

XUM



El Aguila
Rio Pequeni
Qda Bonito
Qda San Juan
San Juan
Qda Tranquillo
Rio Indio
Santa Barbara
Chagres
Old
Dos Bocas
Qda del
Rio de la Puente
El Vigia
Las Campanas
Rio Chagres
Qda Azora Caballo
Qda Marcelito
Rio Chilibrillo
Suggested Dam
Rio del Madroño
ALHAJUELA
Rio Lemon
Qda Los Cerritos
Gatun
Rio Gatuncillo
Path
Cupe
Yaviza
Las Delicias
Rio Eugenio
Qda Gira
Rio Palenque
Maria
Juan Mina
Rio Caballo
Rio Tavernilla
Qda Agua Maria
Aguadiente
Qda Contador
Royal
Cerro Tavernilla
722
Pihiva
Qda Fulano
La Piedra sin Cabeza
Palo Grande
Rio Caseno
Rio Grande
Opispo Guard Gate
705
Cerro Maquincal
951
Cerro Agua Fria
Las Cruces
Cerro Rico
623
Cerro de las Minas
Gamboa
29
30
31
32
OBISPO
Santa Rita
Rio Agua Clara
Rio Gatun
Qda Francisco
Rio Agua Sucia
Qda la Chacarita
C Chagalito
Quebrada Pilo
Rio Chimilla
Rio Agua Salud
Gatun
XUM

SHOWING LOCATION OF PRO

AS RECOMMENDED BY THE ISTHMIAN CANAL COMMISSI

Scale $\frac{1}{100,000}$

Statute Miles

1 3/4 1/2 1/4 0 1 2 3 4 5 6

Nautical Miles

1 3/4 1/2 1/4 0 1 2 3 4 5 6

Kilometers

1000 500 0 1 2 3 4 5 6 7 8 9 10 11

Old paved road from Panama to Portobello

Path to Chagres

Roval Road from Cruces to Panama

Aguila

Pequeni

Rio Indio

San Juan

Chagres

Dos Bocas

El Vigia

Las Campanas

Santa Barbara

Rio Chagres

Rio Chilibrillo

Suggested Dam

ALHAJUELA

Gatun

Cupe

Yaviza

Las Delicias

Juan Mina

Pihiva

Palo Grande

Las Cruces

Gamboa

Cerro Tavernilla 722'

La Piedra sin Cabeza

Cerro Maquincal 705'

Cerro Agua Fria 951'

Cerro Rico 823'

Cerro de las Minas

Opispo Guard Gate

Pedro Miguel Locks

Miraflores Locks

Rio Grande

COROZAL

Mamei Sak

Rio Mariprieta

Rio Lajas

Rio Algarrobo

XUM

SHOWING LOCATION OF [illegible]

AS RECOMMENDED BY THE ISTHMIAN CANAL COMMISSION OF 1899-1902.

Scale $\frac{1}{100,000}$

Statute Miles

1 3/4 1/2 1/4 0 1 2 3 4 5 6 7 8 9

Nautical Miles

1 3/4 1/2 1/4 0 1 2 3 4 5 6 7 8 9

Kilometers

1000 500 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

79° 20'

9° 00'

Old paved road from Panama to Portobello

Path to Chagres

Royal Road from Cruces to Panama

Cerro Tavernilla 722'

a sin Cabeza

Maquincal

Agua Fria

las Minas

Rio Maria Henriquez

Rio Lajas

Rio Juan Diaz

Rio Mariprieta

Rio Matias Hernandez

Rio Algarroba

Rio Camillo

Rio Mato Ahogado

Ruins of old Panama

Pedro Miguel Locks

Miraflores Lock

Pte Paitillo

PANAMA

PANAMA

PACIFIC OCEAN

Las Sivana

PANAMA

Rio Grande

COROZAL

Miraflores

Mamja Saka

Las Tres Hermanas

49 MILES

Fathoms

XUM

CARIBBEAN SEA

BAY

Pta Hala Remo

Pta Caño Principal

Rio Cocoa Sola

BAY OF MANZANILLO

Manzanillo Island

COLON

Lighthouse

Rio del Puerto Escondido

Marajal

LIMON BAY

Fathoms

Pta Toro

Lighthouse

Playa de Flor

Pta Brujas

CERRO SANTA RITA

Pta Naranjitos

Naranjitos

Pta Limon

Jaranillos

San Jose

SIERRA MINDI

Pta Tortuguillo

Fort Lorenzo

CHAGRES

Rio

San Andres

Rio Farnia

Rio Primer Salido

Piña

Rio Chagres

Rio Indio Hquato

Rio Gatuncillo

Rio Trinidad

Rio Boqueron

Rio Caimito

Rio Cirbe

Rio Gatuncillo

Rio Conguel

Rio Tinto de Cirbe

Rio Tinto Grande

Rio Tinto Chico

Rio Tinto de Cirbe

Sucio
Santa Rita
Rio Ensenada
Ave Concha
Rio Agua Clara
Rio Gatun
Qda. Francisco
Rio Agua Sucia
Qda la Chacarita
Q. Chagres
Rio Gatuncillo
Gatun
Cupe
Yaviza
Las Delicias
Juan Mina
Pihiva
Palo Grande
Las Cruces
Gamboa
OBISPO
MATACHIN
GORGONA
Juan Grande
Mamei
Opispo Guard Gate
Cerro Ri
623'
La Soledad
Rio Cano
QUEBRANCHA
Rio Chimilla
Rio Agua Salud
SIERRA
LAGARTO
AHORCA
LOMAS
Monte Lirio
Bohio Locks and Dam
PROPOSED
DIVERSION
Rio Agua Salud
Panama
Frijoles
Buena Vista
BOHIO
Chagresito
SAN PABLO
TAVERNILLA
Rio Frijolito
Rio Chagres
Rio Ceño Quebrado
Rio Paja
GATUN
Ahorca Lagarto
Road
Lion Hill
Carmen Massias
Tiger Hill
Rail
ALTERNATIVE
LOCATION
Peña Blanca
Vamos Vamos
Las Penitas
Palo Horqueta
Caimito
Palo Matias
Bruja Swamp
Vino Tinto Swamp
Dos Hermanos Swamp
PEÑA BLANCA OUTLET
Peña Blanca Swamp
Gigante Spillway
Rio Gigante
RAILROAD
OF PANAMA
Qda. Agua Bendita
Rio Pascoe
Rio Frijolito
Rio Caraballo
Rio Marinos
Rio Baila
Rio Vaquitano
Rio Paja
Qda. Monte Vissaso
Qda. Juan Chiquito Abajo
Qda. Juan Chiquito Arriba
Qda. Tortuoso
Qda. Cano
Qda. Agua Clara
Qda. Agua Salud
Qda. Agua Maria
Qda. Grande
Qda. Contadora
Qda. Fatepe
Qda. Oira
Rio Maria
Rio Valenzuela
Rio Agua Salud
Rio Chagres
Rio Gatun
Rio Grande
Rio Pascoe
Rio Frijolito
Rio Caraballo
Rio Marinos
Rio Baila
Rio Vaquitano
Rio Paja
Qda. Juan Grande
Qda. Cano
Qda. Agua Bendita
Qda. Monte Vissaso
Qda. Juan Chiquito Abajo
Qda. Juan Chiquito Arriba
Qda. Tortuoso

Gatun
Cupe
Yaviza
Las Delicias
Juan Mina
Pihiva
Palo Grande
Las Cruces
Gamboa
Cerro Rico
623
Cerro Maquincal
705
Cerro Agua Fria
951
Cerro de las Minas
Cerro Tavernilla
722
La Piedra sin Cabeza
Path to Chagres
Roval Road from Cruces to Panama
Opispo Guard Gate
Pedro Miguel Locks
Miraflores Lock
Rio Grande
COROZAL
Maria Saka
Pedro Miguel
Miraflores
PARAISO
Road
OBISPO
MATACHIN
Las Cascada
EMPERADOR
CULEBRA
Panama
Rio Grande
Cocoli
3 MILES
La Boca
WHARF
GORGONA
Juan Grande
Mamei
RAILROAD
PANAMA
SAN PABLO
Rio Chagres
Rio Gatuncillo
Rio Pequeni
Rio Eugenio
Rio Caballo
Rio Algarrobo
Rio Caimito
Rio Cascajo
Rio Masambar
Rio Mandigu
Rio Corozal
Rio Velasquez
Rio Caño Quebrado
Rio Peja
Oda Agua Buena
Oda Agua Arriba
Oda Agua Abajo
Oda Contador
Oda Cano
Oda Conga
Rio Agua Fria
Rio Mallejon
Rio Furnio
Rio Juan Diaz
Rio Matanilla
Rio Corozal
Rio Caimitillo
Rio Tavernilla
Rio Maria
Rio Valenzuela
Rio Pacora
Rio Cardoso
Rio Marinose
Rio Concepcion
Rio Mamei
Rio Balsa
Rio Mayanque
Rio Mulato
Rio Pequeni
Rio Caimito
Rio Cascajo
Rio Masambar
Rio Mandigu
Rio Corozal
Rio Velasquez
Rio Caño Quebrado
Rio Peja
Oda Agua Buena
Oda Agua Arriba

Path to Chagres

Royal Road from Cruces to Panama

Cerro Tavernilla 722'

Piedra sin Cabeza

Cerro Maquincal

Cerro Agua Fria

Río Pedro Miguel

Pedro Miguel Locks

Miraflores Lock

Río Grande

Río Algarrobo

Río Caimitillo

Río Matasimbar

Río Mato Asiento

Ruins of old Panama

Pte Paitillo

PANAMA

La Sivana

PANAMA

Las Tres Hermanas

San Lazaro

La Boca

BAY OF PANAMA

I. Perico

I. Flamenco

I. Naos

I. Culebra

Pta Farfan

I. Changarmi

Pta Batele

Pta Bruja

I. Tortola

Venado

Hacienda de Cabra

Río Grande

Río Coco

Río Velasquez

Río San Juan

Río Malagrilla

Río Farfan

Río Fuente

Río Mallejon

Río Concepcion

Río Mandigua

Río Matasimbar

Río Caimitillo

Río Pedro Miguel

Río Algarrobo

Río Mato Asiento

ATLANTIC

Pta Naranjitos

Naranjitos

Arang

NTA RITA

Pta Limon

13

12

Jaramillos

Rio Petibio

SIERRA MINDI

San Jose

Pta Tortuguillo

Fort Lorenzo

CHAGRES

Rio Gatun

Rio Coquisera

Rio

Chagres

Quebrada de Palenque

San Andres

Rio Farnia

Rio primer Salido

Rio Piña

Rio Piña

Rio

del

Mar

9°
20'

80°
10'

80°10'

9°10'

GATUN

Titiasable Cr

Rio Guarapo

Quda Juan Chiquito Abajo

Chagres Diversion

Panama Railroad

Alternative Rail Location

Signal

Tiger Hill

Lion Hill

Monte Lirio

LOMAS AHUMADO

Ahorca Lagarto

Carmen Massias

Santana

BOHIO

Bohio Locks

Buena Vista

Tortuosa

Peña Blanca

Vamos Vamos

Las Penitas

Palo Horqueta

Caimito

Palo Manas

Bruja Swamp

Vino Tinto Swamp

Dos Hermanos

Agua Clara Swamp

Peña Blanca Swamp

Peña Blanca Outlet

Agua Clara

Rancho del Tigre

Rancho Camacho

LOMAS DE PALLENQ

Lagartera

Qda de las Cruces

Quebrada Lagartera

Trinidad

Rio

80°10'

9°10'

80°00' West of Greenwich

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SUPPLEME

XUM

Monte Lirio
Juan Grande
Mamei
Bohio Lock
Bohio Soldado
Rio Agua Sucia
Rio Agua Salud
Quda. Angela
Panama
Prijoles
Buena Vista
BOHIO
Ahorca Lagarto
Road
Tortuoso
Lion Hill
Carmen Mascias
Santana
Tiger Hill
Alternative Location
Chagresito
SAN PABLO
TAVERNILLA
Rio Chagres
Rio Rola
Rio Frijoles
Rio Baila Cocolito
Rio Magueyal
Rio Caribali
Rio Marinoso
Peña Blanca
Vamos Vamos
Las Penitas
Palo Horqueta
Caimito
Bruja Swamp
Palo Manas
Peña Blanca Swamp
Peña Blanca Outlet
Vino Tinto Swamp
Dos Hermanos
Agua Clara Swamp
Gigante Spillway
Rio Gigante
Rio Caño Quebrado
Rio Paja
Agua Clara
LOMAS DE PALLENQUILLA
Rancho del Tigre
Rancho Camacho
Lagartera
Qda. de las Cruces
Quebrada Lagartera
Qda. Lagartérita
Rio Trinidad
Rio Limon
Rio Arados
Rio Pescado
80°00 West of Greenwich
9°00
79°

SUPPLEMENT TO THE NATIONAL GEOGRAPHIC MAGAZINE, WASHINGTON, D. C., OCTOBE

REPRINT

XUM

Juan Grande

Mamei

PANAMA

RAILROAD

Río Chagres

Río Trinidad

Río Mandigo

Río Grande

Río Cocoli

Río Velasquez

Río San Juan

Río Malaterio

Río Bique

Sugar works of Bique

BAY OF

Río Pequeni

Río Vaquenaves

Río Pequeni

Río Pajo

Río Caño Quebrado

Río Mescado

Cerro Mulato

Cerro Quebrado

Qda. Agua Bendita

Qda. Curé

N PABLO

R. 24

R. 23

R. 9842

R. 9843

R. 9844

NOTES

49 — Line of Canal

Panama Railroad

Proposed diversion of Railroad

River diversion

Altitudes and Soundings are referred to Mean Ocean Level

Topography is taken from a map published by the New Panama Canal Co. in 1899; except the Chagres River above Santa Barbara, which was surveyed by the Commission.

Soundings in Limon Bay were taken from Hydrographic Chart Nº 1008 corrected to 1895.

Soundings in Panama Bay were taken from a Ms. map furnished by the New Panama Canal Co. dated March 26, 1900.

9°00 — 79°50 — 8°50

GEOGRAPHIC MAGAZINE, WASHINGTON, D. C., OCTOBER, 1905.

REPRINT

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EMPERADOR

CULEBRA

Cocoli

I. Naos

I. Culebra

Pta Farfan

I. Changarmi

Pta Batele

Hacienda de Cabra

Pta Bruja

I. Tortola

Venado

Playa de Venado

Sugar works of Bique

BAY OF BIQUE

Pta Vaca de Monte

GULF OF PACIFIC

79° 30'

8° 50'

79° 50

8° 50

79 40'

NOTES

49 — Line of Canal

Panama Railroad

Proposed diversion of Railroad

River diversion

Altitudes and Soundings are referred to Mean Ocean Level

Topography is taken from a map published by the New Panama Canal
o. in 1899; except the Chagres River above Santa Barbara, which
as surveyed by the Commission.

Soundings in Limon Bay were taken from Hydrographic Chart N?
008 corrected to 1895.

Soundings in Panama Bay were taken from a Ms. map furnished
y the New Panama Canal Co. dated March 26, 1900.

Oliver B. Harden del.

BER, 1905.

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DUES: Annual membership, $2; Life membership, $50. If check be enclosed, please make it payable to order of the National Geographic Society, and, if at a distance from Washington, remit by New York draft or post-office money-order.

----------190----

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THE NATIONAL GEOGRAPHIC MAGAZINE

THE PANAMA CANAL*

BY REAR ADMIRAL COLBY M. CHESTER, U. S. N.

SUPERINTENDENT U. S. NAVAL OBSERVATORY

IT is not the purpose of this address to go into the history of canal exploration or exploitation. There are a number of routes available for uniting the two oceans which wash the American Continent, and there is still a divergence of opinion as to which is the best locality for building the canal. Several routes have good points, and it has been only by a discussion of the pros and cons, weighted for their relative values, that a final conclusion has been reached as to which is the best. Many years ago this process eliminated all but two of the routes—Panama and Nicaragua—from serious consideration.

THE PROMINENT PART TAKEN BY THE U. S. NAVY

The work of solving the canal problem has fallen largely on the Navy of the United States. Company after company has been formed for the exploration of the different sections which it seemed desirable to examine, but in each and every case they came to the government for assistance, and their requests were referred to the Navy Department. Finally the government itself took up the matter and put it under naval control. The selection of the navy to perform this work was a wise and economic policy. Its officers are educated at a scientific school and drilled in surveying the coasts of the United States as well as in making surveys in all parts of the world covered by the voyages of naval vessels, as required by the following extract from the U. S. Naval Regulations, viz: "He" (the captain) "shall, when his duties and other circumstances permit, make a careful survey and construct a chart of any shoals, harbors, or dangers to navigation that he may discover or find inaccurately located." Such duties make the naval officer well fitted for the work of exploration. Not only was this an enforced duty on the navy, however, but willing hands were found who sought to carry the American flag into and across the inhospitable and almost impenetrable forests which abound in the tropical regions, where Nature herself has almost built a canal.

While many spasmodic efforts were made to cut the Gordian knot, about the

*An address to the National Geographic Society, March 10, 1905.

middle of the 19th century it was seen that nothing but a systematic and scientific treatment of the problem would avail, and one of the first to realize this was the late Rear Admiral Daniel Ammen, U.S.N. He had sought permission from the Navy Department to take charge of a party to explore the Isthmus of Panama early in the fifties, but was refused. Soon after this, civil war broke out in the country, and the navy had its hands too full to consider other than military matters. Hardly had the war ceased, however, before Ammen took up the problem and, enlisting the influence of his great friend, General Grant, he hammered away at it until the day of his death. Fortunately, Ammen was succeeded in that office of the Navy Department having charge of such matters by Rear Admiral John G. Walker, U.S.N. His earnest interest in the subject is demonstrated by the fact that he is now the President of the Isthmian Canal Commission.* But today the canal project owes no man more for its promising future than it owes General Grant.

Well-equipped expeditions were fitted out for surveying the different routes selected for examination by such men as Shufeldt, Lull, Selfridge, Crossman, Collins, Hatfield, all officers of the navy, and when the mass of evidence seemed to be pointing toward Panama as the most favorable site for a canal, a French naval officer came in suddenly and unexpectedly took the stake.

I say this with some fear of contradiction, yet I believe this contention can be maintained. To be sure, a number of the leading men in our country favored the Nicaragua route, and many naval officers were strong in their conviction that its location was the most favorable for a canal, but I claim this view was largely influenced by political considerations and the imperfect knowledge then extant regarding the work necessary to construct a canal on so large a scale.

*Since this address Admiral Walker has been succeeded by Hon. Theodore M. Shonts.

One of the first official acts of the government of the United States in connection with canal investigation was a resolution passed by the United States Senate March 9, 1866, reading as follows:

"*Resolved*, That the Secretary of the Navy furnish, through a report of the Superintendent of the Naval Observatory, the summit levels and distances by survey of the various proposed lines for interoceanic canals and railroads between the waters of the Atlantic and the Pacific oceans, as, also, their relative merits as practicable lines for the construction of a ship canal, and especially as relates to Honduras, Tehuantepec, Nicaragua, Panama, and Atrato lines; and also whether, in the opinion of the Superintendent, the Isthmus of Darien has been satisfactorily explored; and, if so, furnish in detail charts, plans, lines of levels, and all information connected therewith, and upon what authority they are based."

The result of the resolution was a comprehensive report of the whole canal question as far as then known by the late Rear Admiral Charles H. Davis, U.S. Navy, Superintendent Naval Observatory, of which 8,000 copies were printed by order of Congress.

Another able and voluminous report on the "Problem of Interoceanic Communication by way of the American Isthmus" was prepared in pursuance of an order of the Navy Department by Lieut. John T. Sullivan, U. S. Navy, in 1883, which was published in accordance with authority of Congress, and which became a standard reference book on the subject.

THE PANAMA ROUTE

Capt. E. P. Lull, U. S. N., surveyed this route in 1875, and he estimated, as the most practical plan, for a lock-canal of a length of 41.7 miles from sea to sea; but the real origin of the Panama Canal as an accepted project may be found in the brief surveys of Lieutenants Wyse and Réclus of the French navy. On the

6th of October, 1876, Wyse had been authorized by a society called the "Societe Internationale du Canal Interoceanique" to proceed to Central America for the purpose of exploration. His examinations were begun on the Pacific coast about the middle of December, 1876, and terminated in the first part of April, 1877, a period of not more than four months, during which time no part of the expedition penetrated as far as the Atlantic coast. The party, under the charge of Lieutenant Réclus, spent from April 3 to April 20, 1878, making a survey of the valleys of the Obispo, Chagres, and Rio Grande, along the line of the Panama railroad, the level-lines and cross-sections being run up only to the extremities of the then proposed tunnel, and not continuing over the divide.

Armed with this incomplete record concerning the Panama route, but with a concession for building a canal which embraced the whole country of the United States of Colombia, thus including all the proposed routes except Nicaragua and Tehuantepec, Wyse reported to his company in Paris.

On the 15th of May, 1879, an international conference was held at Paris under the auspices of the Paris Geographical Society. The conference was composed of 136 members, of whom 74 were of other nationalities. The conference, which was controlled by the great engineer Count Ferdinand de Lesseps, who had just built the Suez Canal, after mature consideration, but consideration wherein political elements largely predominated, finally concluded as follows: "The conference deem the construction of an interoceanic canal so desirable, in the interest of commerce and navigation, as possible; and in order to have the indispensable facilities of ease of access and use, which a work of this kind should offer before all others, it should be built from the Gulf of Limon to the Bay of Panama." Thus the Panama railroad was a prime factor in inducing the Paris conference to select the Panama Isthmus as the location for a canal. The company which built the railroad held a concession from the Colombian government dated June 28, 1848. The concession, in a slightly different form, had lapsed from a French company which had been unable to control the capital stock, and the grant was revived in favor of Henry Aspinwall, John Lloyd Stevens, Henry Chauncey, and their associates under the name of the Panama Railroad Company, an organization which later, in 1849, was incorporated by the legislature of the state of New York. Under this grant the company constructed the road, and on the 27th of January, 1855, it was completed and the first passenger train passed over the track.

DE LESSEPS' COMPANY

A company, of which de Lesseps became president, was soon formed for the construction a tide-level canal, and because of the prestige of its chief it was an easy matter to obtain subscriptions to its stock. Unfortunately, among the stockholders there was a large element of the poorer classes in France, who believed that de Lesseps would make a fortune for them out of their small holdings, and many of them sacrificed their little all in the scheme. The capital stock of the company of 300,000,000 francs ($60,000,000) was soon half taken up and work began on the construction of the canal. Wyse expected to be named as director general of the canal, but failing to secure what he considered his rights, a coolness sprang up between him and the president of the company which was anything but favorable to the work. Finally, in 1881, M. Réclus initiated the enterprise and began clearing the ground, assembling the plant, and constructing buildings, hospitals, etc. But troubles grew more rapidly than did the canal. No well-developed plans had been prepared, and in fact hardly any one knew

what was required. Directors and engineers of the construction company changed so rapidly that it became a common saying on the Isthmus that "it was worth a man's yearly salary to simply come there, and he was a very poor engineer who could not make a fortune in six months and go away."

In October, 1885, four and one-half years after ground was broken, the state of affairs on the Isthmus was given by one good authority as follows: "There have been moved a total of from 16,000,000 to 17,00,000 cubic meters of earth, 12,000,000 only being from the canal proper, and 88,000,000 are still to be excavated; besides there have been prepared buildings and stables on an extravagant scale, farms and gardens at great expense around headquarters, railroad branches, field hospitals, and roads, three of which are of but little use except for pleasure riding of employés."

It was about this time (1885) that, after several years' absence, it was again my privilege, as commander of the U. S. ship *Galena*, to return to the Isthmus of Panama and become an enforced but interested spectator of the construction work on the canal, and my recollection of the state of affairs accords with that above given. In fact, an eye-witness could foresee even at this early date that the extravagance which prevailed must lead to the failure of the company. For the next three years, while the progress of the first Panama Canal Company's work was at its height, I spent portions of each winter at Colon and watched with increasing interest the operations of the great undertaking. From that time to the present I have never lost faith in the final success of the Panama Canal.

In the meantime a rival company was organized to construct the Nicaragua Canal, and having for a number of years been interested in surveying and having had an extensive association with the officers who had been making explorations in Central America, I was asked to associate myself with others in support of the Nicaragua Company. To all such suggestions I made answer that I was a Panama Canal man first, last, and all the time, and that I believed when the financial elements of the opposing canals were finally settled by bringing up the then estimated cost for constructing the Nicaragua Canal, which was placed at about $45,000,000, to a reasonable basis of not less than $100,000,000, and the French company should fail and sell out its assets for a song, as then seemed to me more than likely, that some new Panama Canal Company could and would build a better canal for an amount, including the purchase price of the defunct company's holdings, less than the cost of a poorer canal at Nicaragua. I have been so strong in this conviction that two years before the Isthmian Canal Commission made its report in favor of purchasing the interests of the reconstructed Panama Canal Company for $40,000,000, I offered to wager that such a finding would be the result of their deliberations.

I must say that my feelings in this matter were not altogether freed from a little bias, owing to the fact that while our own officers had done the principal work of exploration of the canal zones, and when, as it seemed to me, the sentiment of the country was crystallizing in favor of building a canal across the Panama Isthmus, a French naval officer with but little actual exploration to his credit should, by the use of the great name of de Lesseps, come in and steal a march on us.

While on the Isthmus during the latter part of 1887, I ventured to ask Mr Charles de Lesseps, who was then the company's manager, if he really expected, as was then widely published, that the canal would be completed the following year. He replied that, while he would not like to have it known, he did not mind telling me that, in order

to complete it at that time, as well as to procure revenue for continuing the digging down to the sea level, the company might be forced to the lock system of construction. This would surely be accomplished in the end. Before the time limit was up the entire plans of the canal had been changed to the lock system, but as the money was then practically all gone and no more could be obtained, the company was forced into bankruptcy. This took place in February, 1889, but a short time after I left the Isthmus.

THE EARLY PLANS

The plan that was first adopted by the old Panama Canal Company, was for a sea-level canal having a depth of 29.5 feet, and bottom width of 72 feet, with a total length of about 47 miles. Naturally, the estimates for constructional work on the canal at this time were very crude, being based on insufficient data regarding the physical conditions of the country as well as on insufficient surveys. As at first planned, the canal passes through low ground from Colon on the north, by a direct line for a distance of 6 miles to Gatun, where it intersects the valley of the Chagres River, passes up that valley a distance of 21 miles to Obispo, where it follows the valley of a small tributary, cuts through the continental divide at Culebra, and thence descends by the valley of the Rio Grande to the Bay of Panama.

As it was necessary to provide easy curves everywhere in the canal, a point was selected for crossing the divide somewhat higher than that of the lowest pass. The maximum height on the center line in the Culebra Cut was 333 feet above the sea. The greatest problem the company had to solve was the control of the floods of the Chagres, which at times rose to enormous proportions. Various schemes were proposed to meet this difficulty, the most prominent being the construction of a dam at Gamboa to impound the waters of the upper river, and the excavation of two independent channels, one on either side of the main canal, to carry off the surplus waters to the sea.

The cost of the canal as estimated by de Lesseps in 1880 was $127,600,000, and the time required for its completion was 8 years.

As has been stated, in 1887 his company was forced to admit that it was impractical to build a sea-level canal in the time and with the money available, and a tentative scheme for opening the canal in order to precure revenue was adopted which contemplated the use of locks. This being a temporary expedient, the summit level was to be supplied with water from the Chagres River by pumps; but, with the funds exhausted, even this became a hopeless task, the company was forced into bankruptcy, and in May, 1889, work on the canal ceased altogether.

DISAPPEARANCE OF THE SECURITIES

After much difficulty in arranging the concessions, a new company was organized on the 20th of October, 1894, with a capital stock of 650,000 shares of 100 francs each. Thus, after deducting 50,000 shares given as full-paid stock to the Colombian government, in compliance with the terms of the extension of the concession, the cash capital of the company was only 60,000,000 francs, or $11,640,000, a sum which allowed only for some provisional operations then contemplated. It is hardly necessary to go into the scandals connected with the failure of the old company, as they do not affect the problem. The old company and the liquidator had raised by the sale of stock and bonds the sum of $246,706,431.68, while the securities issued to raise this sum had a face value of $435,559,332.80. The number of persons holding them is estimated at over 200,000. There had been purchased and transported to the Isthmus an enormous quantity of machinery and

other plant at an estimated cost of $29,000,000. It is said that the terreplein of Christobal Colon, on which the superintendent's residence was built, was constructed almost entirely of discarded material from this purchase. In fact, I saw a great amount of material so disposed of myself.

It should be noted that the Panama Railroad, which ran over practically the same route as did the canal, was of great importance to the canal company in constructing the canal, not only on account of its facilities for handling supplies, but because the railroad company's concession covered any system of transportation which might be adopted along its line. This made it necessary, in order to control the road, for the canal company to purchase most of its stock, which alone took out nearly $19,000,000 worth of assets.

FEARFUL LOSS OF LIFE

It should also be noted that the sanitary question was not only an important, but a very expensive, item to the company. There was ample provision for caring for the sick, with large and expensive hospitals under control of the company, but little or no attention was paid to precautionary measures, which now are considered such important factors in sanitary science. Those of us who visited Colon in the height of the boom may recall the ghastly scenes which met our eyes. One might witness on almost any morning a scavenger's wagon going about the town gathering up the bodies of those who had succumbed during the night in the hovels of the place or in the streets to the prevailing disease which fed on the filth of the land. The celebrated suburb of Colon, "Monkey Hill," was the receptacle for these corpses, which received in transportation and burial less consideration than would usually be given to a dead dog.

The plan adopted by the new Panama Canal Company, as stated in the Isthmian Commission's report, involved two levels above the sea level; one of them, an artificial lake to be created by a dam at Bohio, to be reached from the Atlantic side by a flight of two locks, and the other, the summit level, to be reached by a flight of two locks from the preceding, the summit level to have its bottom 68 feet above the sea and to be supplied with water from a feeder leading from an artificial reservoir to be constructed at Alhajuela in the upper Chagres Valley; the ascent on the Pacific side to be likewise of four locks, of which the two middle ones are combined in flight; the canal to have a depth of 29.5 feet, and a bottom width of about 98 feet, with an increased width in certain specified parts. Its general location was that adopted by the old company. The cost was estimated at $101,850,000 for the work, which did not include administration or financing; this matter of financing was estimated at nearly $100,000,000. While this was the plan recommended by the French engineers, they worked out in detail a second plan, which is an extension or modification of the foregoing, which they seemed to prefer in itself, but which they feared would require more time to execute. Under the second plan the upper level was omitted, the cut through the continental divide being deepened until its bottom was 32 feet above the sea; Lake Bohio was made the summit level and was fed directly by the Chagres; one flight of locks on the Atlantic side and one on the Pacific was omitted; the feeder from Alhajuela was omitted, but the dam at that place was retained. The estimated cost of completing this plan was not much greater than that for the other, being about $105,500,000. In both plans the dam at Bohio converted the river between that point and Obispo into a lake of such dimensions as not to be seriously affected by the partial floods admitted to it, while diversion channels

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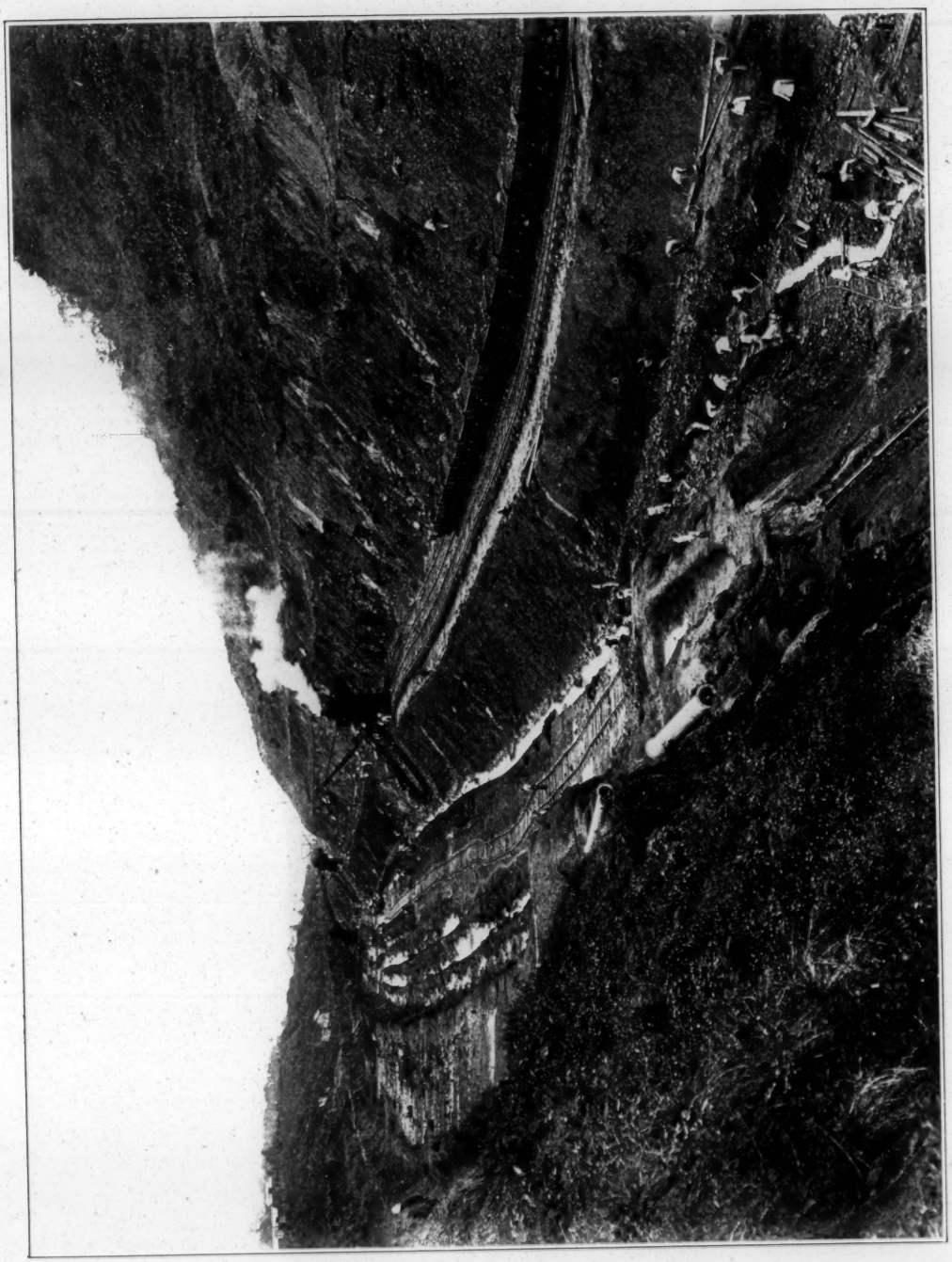
Unfinished Cuts in the World's Greatest Canal

From top of Culebra, looking northwest, toward the Atlantic Ocean

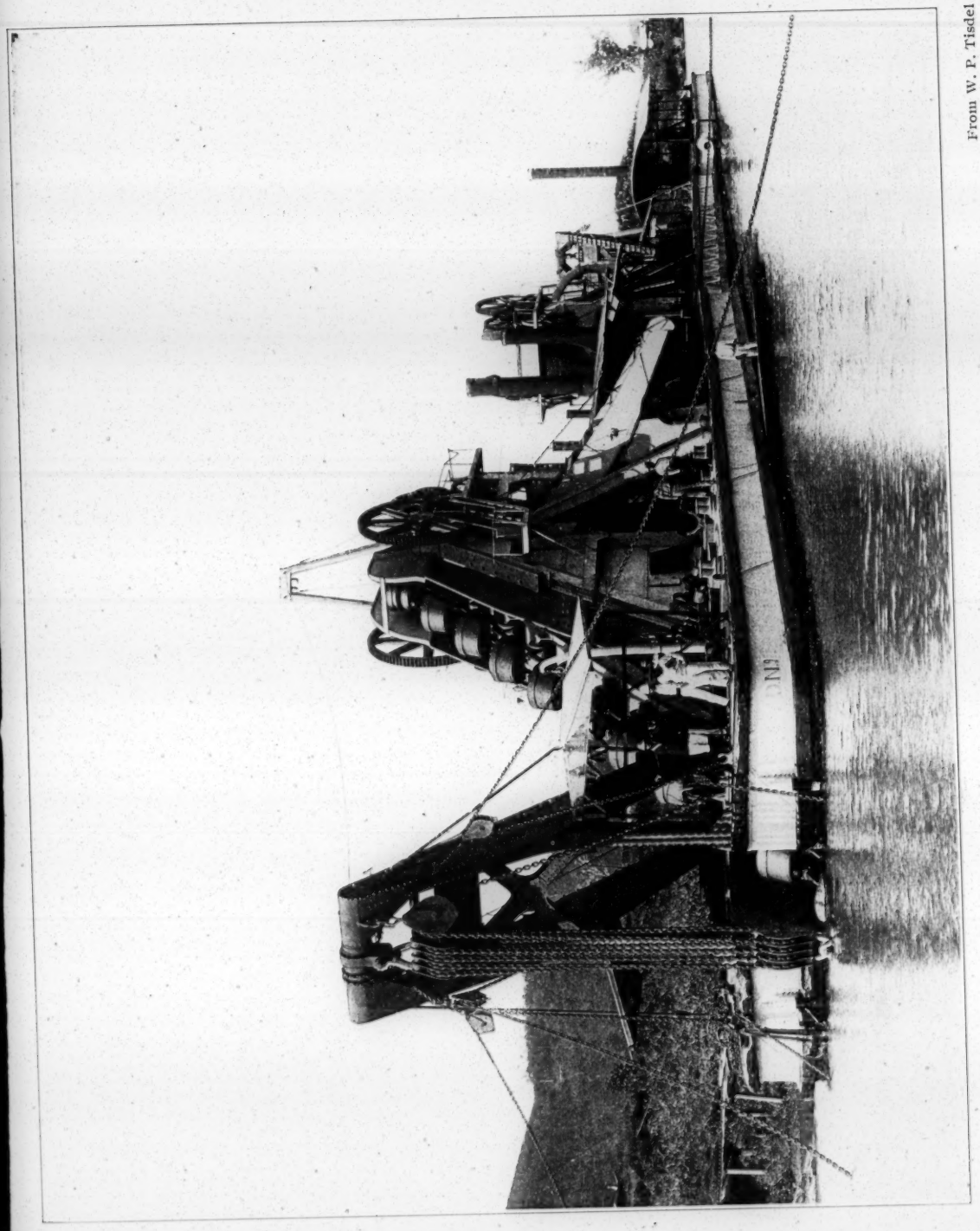
From W. P. Tisdel

Rock Cut at Bas Obispo



From W. P. Tisdel

The Culebra Cut, Looking North



From W. P. Tisdel

Dredge at Gargona

were to be constructed on both sides of the canal from this lake to the sea. With a carefully designed system of sluices and controlling works, the violence of the floods was to be checked by impounding the water both above the Alhajuela dam and Lake Bohio, so as to keep the flow below the Bohio dam within the capacity of the two diversion channels. It will be seen that in brief this second plan of the new company simply does away with the upper level at Culebra and leaves but one continuous stretch on the level of about 32 feet above the sea from Bohio to Miraflores, a distance of 22 miles.

THE PLAN RECOMMENDED BY THE FIRST ISTHMIAN CANAL COMMISSION

The plan prepared by the first Isthmian Canal Commission,* which was made before the transfer of the property to the United States government took place, seems to follow this general plan very closely, except that it raises this section to an elevation of about 90 feet above the mean sea level. This plan was only tentative and depended upon further investigation, which is now being carried on. There can be no question but that for such a stupendous scheme this investigation cannot be too exhaustive, and time used in it will save many months in the final completion of the canal. The Commission is, however, going ahead with such work as must be done in any scheme that may be adopted.

The canal as thus projected may be described as follows: Beginning at the 6-fathom curve in Limon Bay, a channel 500 feet wide at bottom is excavated, curving to the left until it reaches a point just inside the jetty constructed by the old Panama Canal Company. Here it changes direction to the right and is then conducted in a straight line to a point about 2½ miles from deep water in the bay. For about a mile this wide channel is inside the low shore line, forming a narrow but well-protected harbor. Near the apex of this second curve the bottom width is increased to 800 feet for a length of 800 feet to provide a turning basin. From the inner end of the harbor the bottom width of the canal is 150 feet and the level of the water is maintained at sea level for a distance of about 14½ miles to the Bohio locks. This sea-level section is cut through low land or swamps until it reaches Gatun, 6 miles from the initial point, where the first high land is met. In fact a cross-section of the canal prism here is so high as to make it possible to construct the first locks—a contingency which is still an open question.

At Bohio is located a double flight of locks, having a total lift varying from 82 feet at the minimum level of the lake to 90 feet at the maximum, 41 to 45 to each lock, the normal lift being 85 feet.

ARTIFICIALLY CONSTRUCTED LAKE BOHIO

While there is some question about the feasibility of locating locks at Gatun, the Commission was of the opinion that no location suitable for a dam existed in the Chagres River below Bohio, and, while this location is not without difficulties, it has the great advantage that about 3 miles southwest of the dam, near the head of the Rio Gigante, the tributary of the Chagres, there exists an excellent site for a spillway, by which the discharge from the lake can be kept away from the dam and accessory works, even when extremely large, without inconvenience to the canal itself or to the country below the lake. The height of this spillway would regulate the height and area of the lake. After careful consideration of the requirements for flood control and for storage against deficiency in the dry season, and also of the effect upon the amount of excavation required

* See map of the Panama Canal region published as a supplement to this number.

for the canal through the continental divide, the Commission decided to fix this height at 85 feet above mean tide, and to make the spillway a fixed weir 2,000 feet long. The area of the lake at this height is 38.5 square miles.

Above the Bohio locks the canal enters the artificial lake formed by the dam and known as Lake Bohio. For the first 7 miles it will become a broad, deep body of water, affording room for anchorage as well as navigation. The length of the channel in Lake Bohio is about 12½ miles from the locks to the point where the canal leaves the Chagres River or 13½ miles to the point where it enters the cut through the mountain divide which separates the Atlantic and the Pacific slopes.

Near the entrance to the summit cut at Obispo will be placed a pair of gates 100 feet wide, so that if it should be necessary to draw off the water from the summit cut the level of Lake Bohio would not be affected by it.

It should be noted that the Commission's plan to increase the height of Lake Bohio from 32 to 90 feet gives it the increased area by distributing the impounded waters over a large section which would not be covered by the lower level. The higher level also allows a great saving in the excavation of the canal prism in this section, and should it be used will probably reduce the total amount of cost for excavation. At all events, as it will not take much longer to raise the vessels the additional height in the locks, but will allow for a greater speed in the lake, the time of their passage through the canal must be shortened.

The summit of "Culebra Cut," as it is called, is nearly 8 miles long from the Obispo gates to the Pedro Miguel locks. The highest point of the divide is about 5 miles from the Obispo gates, where the canal axis is 286 feet below the natural surface of the ground.

The Pedro Miguel locks, the beginning of the next section of the canal, will be similar to the Bohio locks, the aggregate lift varying from 54 to 62 feet. The level of this section is therefore about 28 feet above the sea, and it extends for a distance of 1.33 miles to the last lock, which is at Miraflores.

The Miraflores lock has a lift varying from 18 feet at high tide to 38 feet at mean low tide.

For a little over 4 miles beyond the Miraflores lock the canal extends through a low, swampy country through which the Rio Grande flows. This brings the canal to a point known as La Boca, where the Panama Railroad Company has constructed a large and substantial wharf. A dredged channel 200 feet wide will extend from this point for about 4½ miles to the 6-fathom line in Panama Bay.

COLON HARBOR

One of the most important questions in the canal problem, which heretofore has received practically no attention from any of the companies which have had to deal with the canal, is the construction of a harbor at its northern entrance. A committee has recently reported to the Commission a solution for this problem which contemplates the construction of a breakwater at Colon at a cost of $6,500,000. Indeed, this decision has come none too soon, for already material for the construction of the canal is arriving at Colon, which must be the main depot for the reception of canal supplies, and the difficulties for transshipment are great. There is a small harbor which has been made by widening the canal prism at Christobal Colon, but it is too small and too dangerous of approach for vessels of any size in stormy weather, and as Limon Bay is at the present time an open roadstead, almost any weather may be considered stormy there.

THE TERRIBLE NORTHERS AT COLON

Naval officers who have had for the past half century to police the Isthmus of

Panama and protect its transit have had many disagreeable experiences while anchored in the harbor of Colon or Aspinwall, as it used to be known. One event in my own service there I can hardly recall even at the present day without a shudder. It was in the winter of 1886 when we reached this port with some of the *Galena's* machinery needing repairs. After coaling from a Norwegian barque, which was lashed alongside the ship with much difficulty, owing to the heavy sea, we began to take the machinery apart. Realizing, however, that if caught by a "norther," which might come up at any time—without power to move the ship out of the harbor—disaster was likely to follow, I decided to proceed to the little closed harbor of Porto Bello, which lay about 30 miles to the eastward of Colon, and there make the necessary repairs. At the end of two days, when about to return to Colon, word was received through the commanding officer of a French corvette that during our absence a heavy norther had occurred at Colon, and that the French ship had escaped from the harbor almost by a miracle. As that vessel was a much higher powered steamer than the *Galena*, I cannot bear to think of what might have occurred had we remained in this treacherous harbor. Returning to Colon as soon as possible, the sight that met our gaze I shall never forget. Nineteen vessels had been totally destroyed by the terrific storm, and wreckage and dead bodies strewed the beach for miles around. The barque from which we had taken coal was driven ashore at Christobal Colon, near which we had been anchored, and there was not a vestige of her in sight. A similar fate would surely have been the *Galena's* had she remained in the harbor with her motive power inoperative. Over 50 lives were lost in this storm and the destruction of property was enormous. No doubt this loss of property took a large share of the money which was unaccounted for belonging to the canal company.*

THE PROBLEM OF SANITATION

Few persons who have not visited the Isthmus can have any conception of the magnitude of this problem, and only those who witnessed the great waste of life and money from the want of proper sanitary measures during the closing months of the old Panama Canal Company's existence can form a proper estimate of the value of good sanitary conditions in this trying country.

It should be remembered that practically all of the labor used in the canal section must be imported. At first, under the influence of de Lesseps' great name, large numbers flocked to the Isthmus from Jamaica, which island is said to furnish a class of labor second to none for tropical work. Impetus was given to this emigration of the islanders by the fact that the trade in sugar, which was then the staple article of production in Jamaica, was ruined by the bounty paid for the cultivation of this important commodity in our own southern states, and the great fruit business which now gives the island considerable revenue was then in its infancy. It was therefore not a difficult matter for the company to make contracts with the idlers to go the short distance to the Isthmus, where good prices for labor prevailed. But when, after a comparatively short time, a few decrepit negroes returned to their homes in an endeavor to eradicate from their systems the effects of diseases, with reports that the thousands who did not return had gone to their last resting places, a reaction set in and the Jamaica market became less available. Further, the British government, seeing their beautiful island overrun by paupers who had returned from the Isthmus without the power of earning the food for their depleted bodies, finally put a stop to this emigration altogether.

* See page 472.

From W. P. Tisdel

A Steam Shovel at Work in the Culebra Cut

SCOURING THE WORLD FOR LABORERS

Then the coasts of Africa were scoured for able-bodied men, but even there after a short time the promises of remunerative prices for their services ceased to draw men to the canal zone. I have seen a ship come into the port of Colon from the coast of Africa, where it had been sent under a most liberal contract on which it was expected to bring 1,500 or 2,000 men for the canal working parties, with only one or two hundred on board. It was estimated that their passage money cost the canal company in the neighborhood of $1,000 apiece, and yet one-half of them were invalided to the hospitals almost as soon as they landed. Thus the enormous cost of the voyage was the principal result of such expeditions.

PREVENTIVE SANITATION

The climate was not so much the cause of this awful havoc among the laborers as the want of preventive sanitary measures. My experience, which has covered portions of five or six years in Isthmian waters, leads me to approve what has been reported by the U. S. minister to Panana as given in THE NATIONAL GEOGRAPHIC MAGAZINE of October, 1904. It will bear repeating here. He says:

"When the able sanitary corps, which has charge of bettering the health conditions in the Isthmus has carried out its plans for the improvement of the canal strip and the cities of Panama and Colon, there is no reason why the Isthmus should not be one of the healthiest places in the world. . . . There has been hardly a single instance of serious illness among the considerable number of young men employed here in work connected with the canal, while the percentage of sickness among the larger group of laborers employed at Culebra is not greater than among those engaged in similar excavating work in the United States. Among the 400 marines located half way across the Isthmus, at Empire, there has not been a single death from local diseases, while the percentage of those in the hospital is not larger than would be found at the average post in the United States."

THE SANITARY PRECAUTIONS TAKEN BY THE U. S. NAVY

As the sanitary condition of the Isthmus is in the hands of army and navy officers, I want to make a statement concerning what I consider a reflection on these services made by a lecturer before this representative body only a few weeks ago. Lest we forget!

A distinguished medical gentleman who recently lectured here stated that neither in the curriculum of the U. S. Naval Academy nor at West Point was any attention paid to the subject of physiology or hygiene, which accounted in part for the great sacrifice of human life which took place among our forces during the Spanish-American war in 1898. While the statistics he gave are based mainly on army records, he by inference made them apply to the navy as well.

As far as the U. S. Navy is concerned, his premises are wrong and his conclusions are wrong. In the first place, there is a chair of physiology and hygiene at the Naval Academy (and one was later established at West Point), which is and has been occupied by distinguished medical officers of the navy, and the young men there undergoing instruction are given a very good general knowledge of physiology and hygiene—sufficient at all events to enable them as executive officers of ships to understand at least the questions which arise in the practical parts of the profession. Each ship in our navy carries one or two and sometimes three medical officers, so the sanitation of our ships is well provided for. In fact, the success that has followed the navy's efforts to stamp out

disease has been a source of pride. No brighter page in the history of sanitary science can be found than that which pertains to the medical records of the navy during the summer of 1898. To prove this let me quote from the report of the Surgeon General of the Navy dated October 1, 1899:

"In the returns from the squadron operating in Cuban waters are represented 48 vessels, with an average complement of 11,599. As showing the effects of war service upon the crews of the various types of ships, the monitors gave an average rate per 1,000 of force sick daily during the war of 17.48; for 1897, 10.87; battleships, 12.34, against 12.38 in 1897; cruisers, 16.01, as against 17.31 for 1897; gunboats, 15.74, as against 20.14 for 1897."

THE HEALTH OF OUR SQUADRONS IN TIME OF PEACE AND WAR

So that for this squadron, in spite of diseases especially incident to the tropics in midsummer, the daily average sickness for the whole force of nearly 12,000 men was but 1.56 per cent.

Thus it will be seen that, leaving out the monitors, the average sickness during the war of 1898 was less in reality than in the peace year 1897, when our squadrons summered at some of the health resorts along our Atlantic coast; but, even including the monitors, the general average of sickness is less for the war period than that for the "trying times of peace." Sailors have a trite saying that "those who go down to the sea in ships see the wonders of the deep, but those who go in monitors see the infernal regions." This record of comparative sickness for the monitors would seem to lend credence to this statement.

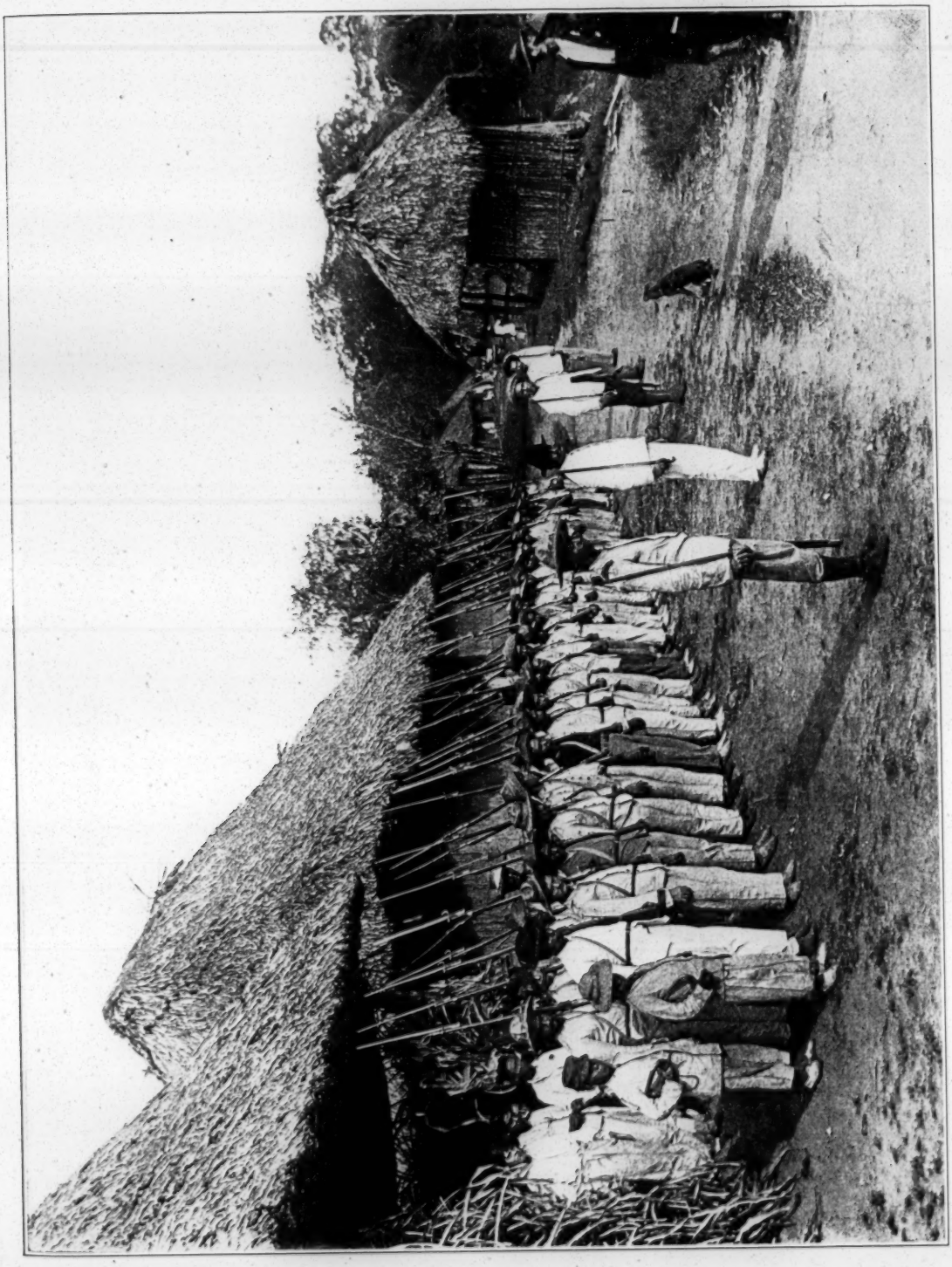
A slightly better result than this was obtained from Admiral Dewey's squadron in the Philippines during the same period.

It may be remembered also that the Navy Department sent a battalion of marines to Cuba during the war period, the average strength of which was 588. On June 10 a landing was made at Guantanamo, where the battalion was in camp for the remainder of the war and until some time after the main force of the army had left for home. The daily average of this force sick was but 2.23 per cent. Remember, this was shore service, the same as in the army. The Surgeon General's report continues: "There were six deaths, all of which occurred in the engagements with the Spanish troops, *not a single fatal case occurring from disease.*" If there is any town in the United States with an equal number of inhabitants that had less sickness for the same period, I would like to see the statistics. Let this statement be compared with Japanese records and the disparagement will not appear so great as that given by the learned doctor.

With the sanitary corps on the Isthmus in charge of such men as Col. William C. Gorgas, U. S. A., chief sanitary officer, whose record as a destroyer of yellow-fever germs in Cuba recently has given him fame, assisted until recently by Medical Director John W. Ross, U. S. N., director of hospitals, and other officers of the army and navy, we need not fear the result of any comparisons made under like conditions with any people on the globe. Dr Ross has been connected with various important sanitary enterprises during his long and useful career in the navy. As long ago as 1878–1879 he made an enviable record as a volunteer in the yellow-fever epidemic of east Florida, for which he was promoted by special act of Congress in 1888.

THE PANAMA PURCHASE A GREAT BARGAIN

That the government of the United States has secured a great bargain in the purchase of the assets of the Panama Canal Company is beyond question. When de Lesseps undertook the man-



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Panama Soldiers at a Village on the Bayano River, Guarding the Pass on the Route from Colombia

agement of the great enterprise which should cut the western continent in two he laid great stress on the fact that problems that seemed insolvable at the time would become simplified by the growth of engineering knowledge developed in the course of the construction work. No engineering scheme has ever been so exhaustively studied as that for building the canal. Immense sums of money have been spent to study the *don'ts* of the problem and still larger amounts have gone to eliminate the *misfits* of the personnel who should control its destiny. No value can be set on this accumulation of knowledge which the Commission can use as a powerful weapon in weaving together the new plans which are to bring our work to a successful issue.

But aside from these "consequential damages," as they might be called, and which would have cut a large figure in the beginning of operations in any new field, the visible assets turned over to the United States are well worth the price paid for them. The popular mind is rather apt to estimate the property delivered to us by the French company as consisting of but little more than the partially dug canal and the Panama Railroad, but a study of the schedule of equipment will show scores of machine shops, some 2,500 houses built of wood, stone, and metal, for all conceivable purposes, and which will accommodate from 15,000 to 20,000 people; hospitals, extensive in numbers and in size, which represent an investment of a vast sum of money. These buildings not only account for a good slice of the purchase price, but as they would all have to be built before work can be systematically carried on, the government is saved the expense of these preliminaries. The labor question, always a serious one, here becomes vital. The loss by sickness alone, before the people who are required to work on the canal could be comfortably housed, would greatly augment the total cost of construction. This expense account would be a large factor in any original operations, say at Nicaragua.

One of the greatest benefits that has accrued to us and on which no money value can be placed is our power to absolutely control the 10-mile strip bounding the limits of the canal zone. No one who has not had to deal with the delicate questions which constantly arise on the Isthmus with reference to our government's guarantee to keep open the transit and to safeguard the sovereignty of the country through which it passes can realize the difficulties and expense which this sacred obligation has entailed.

A SEA-LEVEL CANAL

The first definite engineering plans for the construction of the Panama Canal have just been submitted to the Isthmian Canal Commission under date of February 14 last by the engineering committee of that body, consisting of Commissioners Burr, Parsons, and Davis. The principal recommendations are summed up in this resolution:

"*Resolved*, That this committee approve and recommend, for adoption by the Commission, a plan for a sea-level canal, with a bottom width of 150 feet and a minimum depth of water of 35 feet, and with twin tidal locks at Miraflores, whose usable dimensions shall be 1,000 feet long and 100 feet wide, at a total estimated cost of $230,500,000. Such estimate includes an allowance for administration, engineering, sanitation, and contingencies amounting to $38,450,000, but without allowance for interest during construction, expense of zone government and collateral costs, and water supply, sewers, or paving of Panama or Colon, which last items are to be repaid by the inhabitants of those cities."

The committee estimates that a sea-level canal can be completed within from ten to twelve years from the present time.

The committee decided that under no

circumstances should the surface of the canal be more than 60 feet above the sea, and estimates that at this level the cost would be $178,013,406. A 30-foot level is estimated to cost $194,213,406.

It is recommended that the Chagres River be controlled by a dam at Gamboa, built to a crest height of 200 feet, and the waters of the lake thus created disposed of through tunnels. The work on the foundation of the dam will require from one to one and a half years, and the committee reports should begin at once. The dam at this place, it is stated, involves no formidable obstacles, which is not the case at the Bohio location.

The construction of a dam at Gamboa in this connection would also control the Chagres River, except that it would be necessary to provide a safety spillway by the construction of a tunnel some eight miles in length through the divide, discharging the surplus waters of the Chagres into the headwaters of the Juan Diaz, or the alternative plan of constructing a tunnel four miles long through the divide separating the Chagres Basin from the headwaters of the Gatuncillo, a stream which enters into the Chagres Valley at Gatun. Should this latter course be adopted, it would be necessary to construct an auxiliary channel for the Chagres from Gatun to the sea in order to divert its flood waters into the bay eastward of Colon.

The dam would also provide the water supply for the entire line of the canal, including the cities of Panama and Colon. It would also provide a plant for the generation of electric power sufficient to furnish ample power for the operation of the Panama Railroad and for the operation of any machinery that might be used in the construction of the canal. It would require two years to construct this dam, and, roughly estimated, its cost, including spillways, would be between $15,000,000 and $16,000,000, not including the power plant.

Actual work in the Culebra Cut has demonstrated that the entire excavation can be done at a saving of $15,000,000 over former estimates, and is given as a justification for the recommendation for a sea-level canal.

Immediate work is recommended at Colon in constructing a safe harbor. To this end, an outer breakwater is suggested, as well as the construction of an inner harbor at the entrance to the canal. It is recommended that bids be invited for this work.

Other minor features of canal construction recommended include completing the Gatuncillo diversion channel, begun by the old canal company to divert from the canal the Gatuncillo and Mindi rivers and other smaller streams. In connection with this, three small dams must be built—two across the Chagres River near Mindi and one across the Boca Mindi. All of this work is independent of the decision as to a level for the canal, and its immediate execution is recommended. Other subsidiary features depend on the level determined on and are not discussed.

The committee makes these observations in summing up:

"The practicability of certainly and satisfactorily controlling the floods of the Chagres by so simple and economical a method as the Gamboa Lake and its outflow channels, and the reduced cost of excavation as actually demonstrated by the work of the Commission in the Culebra Cut, makes the construction of a sea-level canal at a reasonable cost far more available than has heretofore appeared possible. These recent developments in the conditions attending the construction of the canal are so important as to be almost controlling in character. The remaining element is that of the time required to make the great summit excavation.

"It is to be carefully observed that the results thus far obtained in the Culebra Cut have been reached under disadvantageous conditions of both organization of plant and force. The

railroad tracks serving the excavators are yet fragmentary and tentatively placed to serve the purposes of investigation. In both respects the disposition of plant is far more unfavorable, both to economy and celerity of operations, than will be the case when a complete track system has been arranged and laid down to serve a large number of steam shovels operated by an experienced force.

"In the face of these disadvantageous conditions the cost of excavation has been reduced far lower than was anticipated, and it has been demonstrated that each steam shovel may be counted upon to yield an average record of at least 1,000 cubic yards per working day. The chief engineer estimates that with 100 steam shovels installed, with a complete system of tracks serving them, a yearly record of 30,000,000 cubic yards of excavation may be reached without requiring a greater output per shovel or greater speed in working than has already been attained. The rate of working could probably be reached within two years from the present time.

"With the rate of progress which now appears reasonable to anticipate, this committee believes that a sea-level canal, with a tidal lock 1,000 feet long and 100 feet usable width at Miraflores, can be completed within ten to twelve years from this time, the bottom width of the canal being 150 feet and the minimum depth of water 35 feet.

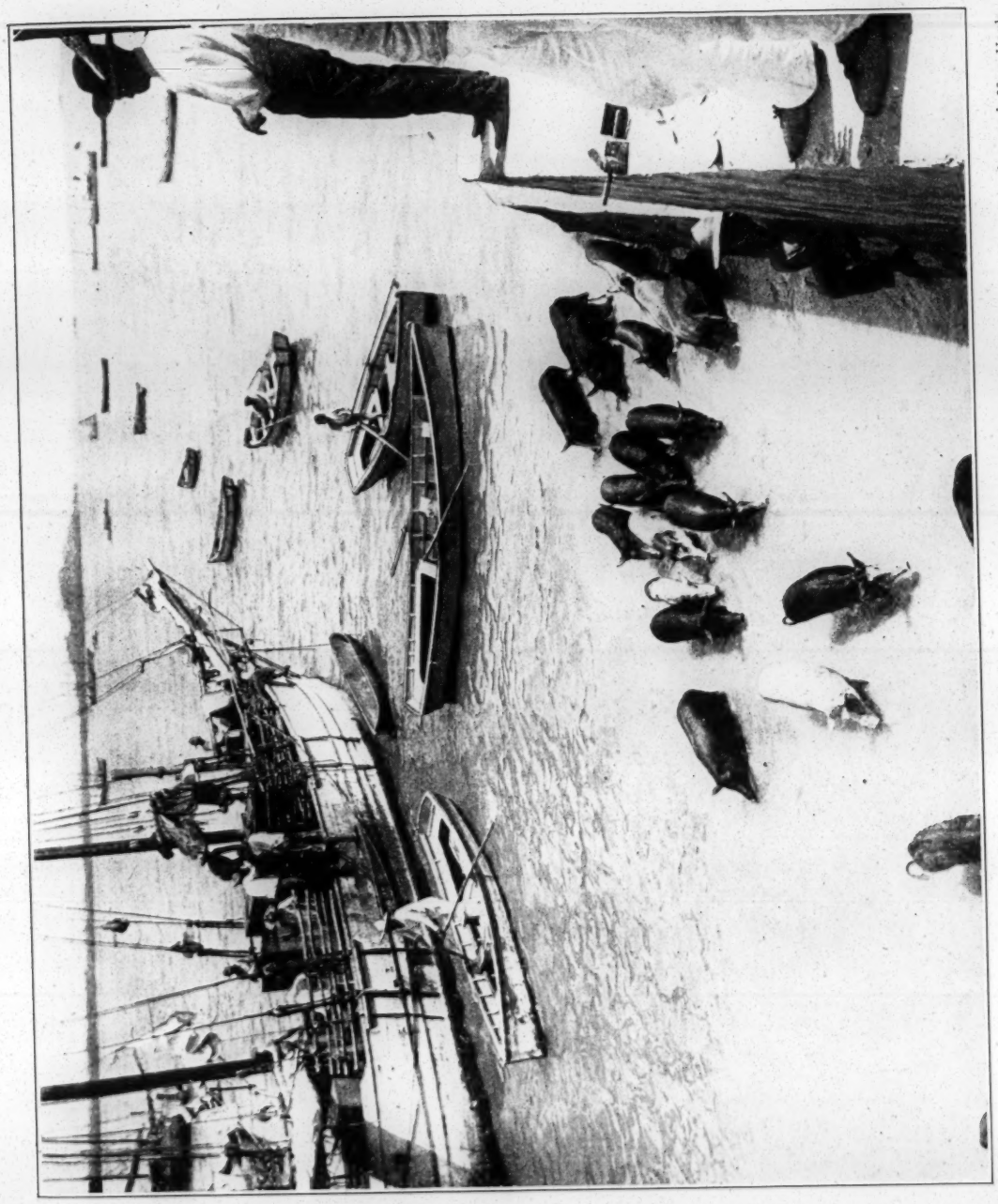
"These considerations have induced this committee to express to the Commission its unanimous judgment that with the contemplated system of working and with the rate of development which appears to be justified by the work now being performed at Culebra, a sea-level canal, free from the restriction of locks, should be adopted. This committee believes that such a canal, with terminal harbors, can be constructed for a sum not exceeding $230,500,000.

THE ADVANTAGES OF A SEA-LEVEL CANAL

"The advantages of a sea-level canal across the Isthmus are most obvious. It would be a waterway with no restriction to navigation, and which could easily be enlarged by widening or deepening at any time in the future to accommodate an increased traffic without any inconvenience to the shipping using it, whereas a lock canal is in reality a permanent restriction to the volume of traffic and size of ships that use it. Although it is possible to design and construct locks adapted to the future transformation to a sea-level canal, that transformation cannot be made without serious inconvenience to navigation and at a cost so great as to be excessive.

"The additional cost of a sea-level canal over that of a canal with locks, with a summit level of 60 feet above mean tide, is $52,462,000, or $79,742,000 more than the estimated cost of the lock canal, with a summit level 85 feet above mean tide, proposed by the former Isthmian Canal Commission, after allowing $6,500,000 for the Colon breakwater and direct entrance not previously estimated. This committee considered this additional expenditure fully justified by the advantages secured."

From this latest report from the canal zone it would seem that there is a possibility of the Commission going back to the first plan of the old Panama Canal Company, and this seems to me, and indeed it has always seemed to me, to be a most desirable outcome of the vast amount of work, thought, and intelligence that has been given the matter. The sea-level canal will surely cost more than if it be constructed on the lock system, but it is more than probable that enough will be saved for maintenance during, say, a fifty-years' service of the canal to pay for the increased cost, and the saving to the 10,000,000 tons of shipping which it is expected will use this great highway of commerce in demurrage will more than compen-



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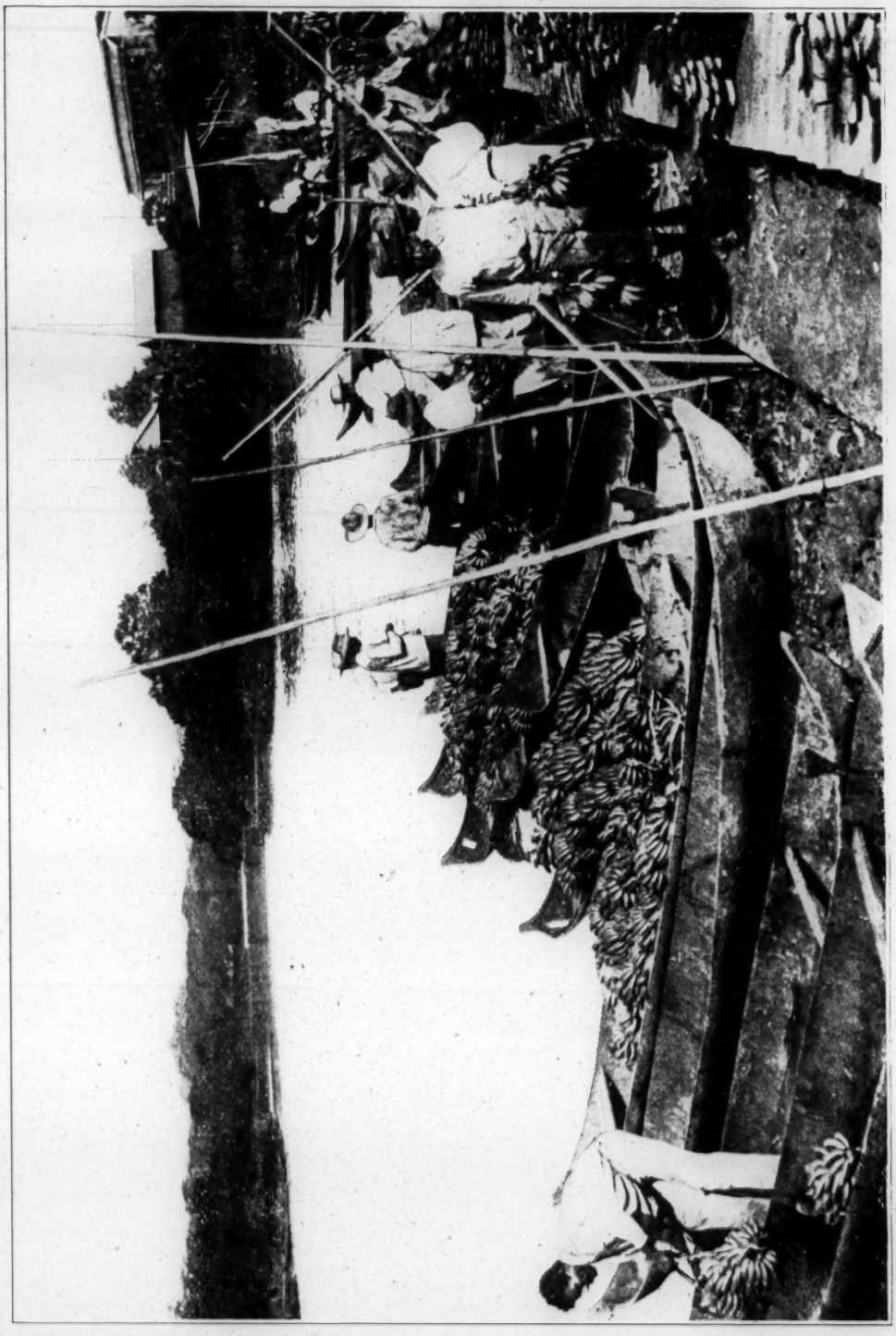
Landing Pigs for Market in the Harbor of Panama City



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Indian "Dug-Outs" on the Chagres River, Bringing Bananas, the Chief Export of Panama, to Gatun

sate the people of the United States for the outlay.

As was expected when de Lesseps began his work, wonderful strides have been made in the science of engineering during the last quarter of a century. We can never say that the ideal has been accomplished, but we may state that the science of engineering has reached such a state within the past few years that with the intelligent management which is now being given to the canal problem a new standard in engineering will be set for the peoples of the whole world by American pluck, perseverance, and skill.

PROGRESS ON THE PANAMA CANAL

THE map of the region of the Panama Canal, which is published as a supplement to this number,* shows the plan submitted to Congress by the Isthmian Canal Commission of 1899–1901. It is the only plan on which the Canal Commission has as yet any authority to spend money, and is described by Admiral Chester in his address to the National Geographic Society, published in this number, pages 455–456. The plan will undoubtedly be very largely modified in the near future, but the map will, we hope, serve as a guide to the members of the National Geographic Society in the discussion and changes of the coming months. The most striking feature of the plan here presented is the great lake (shown in light green on the map). The lake covers an area of nearly 40 square miles, and would be artificially formed by the construction of the giant

* Through the courtesy of Hon. Theodore P. Shonts, President Isthmian Canal Commission.

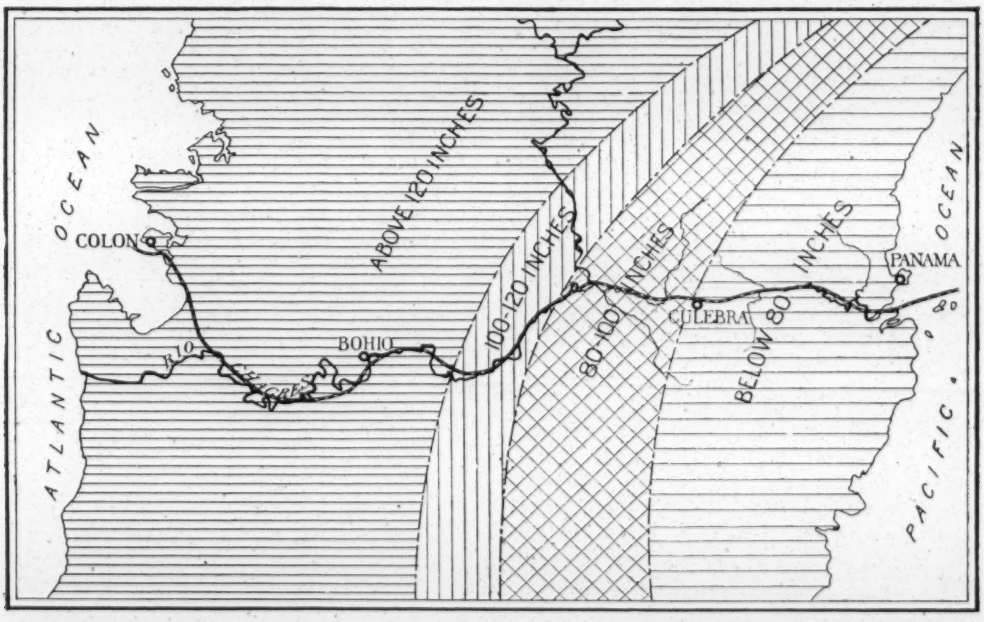

Diagram showing Yearly Amount of Rainfall in Inches on the Panama Isthmus

dam at Bohio; but the trouble with this project is that it entrusts too much to the Bohio dam. If the dam gave way, 10 miles of the waterway would disappear and the canal would be put out of business for years.

The investigations of the American engineers during the past two years have brought to light a number of new and important facts which promise to simplify the two principal engineering problems connected with the canal: (1) The control of the torrential floods from the River Chagres and (2) the Culebra Cut. These results are described by Admiral Chester on pages 462–463. The discovery that it will be necessary to go down 170 feet below sea level instead of 128 feet in order to reach bed rock at Bohio makes the plan of the dam at Bohio almost impracticable. Our American engineers have, however, found a better site for a dam at Gamboa, and it is now proposed to construct the dam to control the Chagres floods at this point. The lake thus created would cover about 10 square miles and would be entirely out of the canal.

The building of the dam at Gamboa will not only furnish complete and effective means of control for the Chagres floods, but it has the further advantage of being entirely accessible by the Panama Railroad for the transportation of men and materials. The plan of the dam will probably require a masonry core, with a great mass of earth and rock fill on either side of it, from the waste excavation of the summit cut.

The conditions attending the construction of this dam are in no way unprecedented. The depth of bed rock below water surface is only about one-third that at Bohio and no greater than has already been reached by the use of heavy timber sheet piling for founding masonry structures in the United States.

The proposed height of this dam from its foundation to its top is far less than found in a number of masonry dams already built, and the making of the earth embankments on the two sides of the masonry core is simply wasting the material from the summit cut. The construction of the Gamboa dam, therefore, involves no formidable obstacles not heretofore successfully encountered in engineering practice.

Experiments made with American steam shovels show that the Culebra Cut can be made in about one-half the time and at about two-thirds the expense formerly estimated. The length of time originally believed necessary to cut Culebra Hill down to sea-level was the reason that the First Isthmian Canal Company recommended a canal with locks. In view of the diminished expense and the great reduction in the estimate of time required for Culebra Cut, general sentiment seems to be that we should construct a sea-level canal and nothing else. But no plan has as yet been definitely adopted.

WHAT PLAN WILL BE ULTIMATELY ADOPTED IS UNDECIDED

"I haven't as yet the slightest idea what plan the advisory board will recommend for the Panama Canal, and I am certain that not a member of the board has." These were the parting words of a prominent member of the International Consulting Board of Engineers on the Panama Canal as he stepped on board the steamer which carried the consulting engineers to Panama in September, 1905. The board had been in session for several weeks in Washington. It had listened to the various plans submitted by Messrs Bunau-Varilla, Bates, and others, and had digested the results of the past two years' surveys and investigations on the Isthmus by the Walker and Shonts Commissions. But no vote had been taken, nor is any definite decision to be sought until the board has been carefully over the ground together. Not a single member of the board is new at the Panama problem; every engineer

has, in some capacity, been associated with it from 5 to 25 years and knows the tremendous difficulties to be overcome. Their decision will be submitted to the Isthmian Canal Commission which may accept it or not as they deem best. The Isthmian Canal Commission recommend to Congress, which alone has the power to determine the plan.

MR BUNAU-VARILLA'S SCHEME

Next to the sea-level canal, the most interesting project is that proposed by Mr Bunau-Varilla. Mr Varilla asserts that it will take the United States many years to construct a sea-level canal, owing to the great difficulty we shall have in securing sufficient laborers. He advocates a plan of his own invention, which he says can be completed in four and one-half years. The canal would be large enough to handle double the amount of traffic which statisticians have calculated will use the canal during the next generation, and can gradually be converted into a sea-level canal without interruption of traffic. Mr Bunau-Varilla's preliminary canal is not unlike that recommended by the first Isthmian Commission, and shown on our supplement. The most interesting feature of the scheme is a dam at Bohio, built entirely of mud and without any artificial core, and of nearly twenty-five times the width of the dam proposed by the Isthmian Commission. The dam would be formed of sandy clay, which is to be sucked up by dredges from the Chagres Valley, and then forced through pipes and deposited in the required position and allowed gradually to harden. The mud, Mr Varilla says, would harden in the manner of cement, and in this way the dam could be constructed at very small expense.

The amount of water that would filter through the ground below the dam would be insignificant. The dam would form a lake, similar in position to the lake shown on the map and extending to the vicinity of Gamboa. At Gamboa another dam built of concrete and steel and strengthened by embankments of earth would form a second lake outside the canal line. Mr Bunau-Varilla proposes two locks at Bohio, ascending to Lake Bohio, and two more locks near Obispo for the ascent to the summit level, which extends from Obispo through Culebra Cut. As the summit level is 130 feet above the sea, the amount of excavation in the Culebra Hill is comparatively small. There are four locks on the Pacific end, making eight in all for the canal.

A CONVERTIBLE CANAL

This serviceable lock canal, which is to be put into commission four and one-half years from the day of commencement, Mr Bunau-Varilla proposes to lower to sea level entirely by dredging. Lake Gamboa is to furnish the electric power to drive the dredges, while into it is to be dumped all the excavated rock and mud. The flow of excavated rock and ground into Lake Gamboa will go on, says the designer, at the rate of 4,000 cubic yards an hour, or 90,000 cubic yards a day, with a very ample margin of safety for accidents. Lake Gamboa, owing to its enormous dimensions, may absorb many times the total cube to be excavated from the canal.

A LABOR-SAVING DEVICE

The following paragraphs are quoted from Mr Bunau-Varilla:

"In all countries of the world dredging is incomparably superior to dry excavation when the ground necessitates no mining. On the Isthmus of Panama this advantage is transformed into an enormous superiority. If there is an instrument of work which counterbalances as much as it is physically possible all the evil influences of the Isthmus, it is the dredge. It counterbalances them because, first, it is the only excavating instrument where the

white man can work without expense of physical energy, where he can work seated, so to speak, protected from the sun, protected from the rain; second, because it is the only instrument where the colored man remains under immediate supervision, where he is attached to tasks always the same and under the eye of the overseer; third, because it is the instrument least liable to suffer from an error or an accident. If a little slide comes it withdraws and is not buried, as an excavator or a steam shovel. If the attack of the ground is too hard, it simply stops instead of risking to lose its equilibrium; it does not derail," &c.

DREDGING WAS PREFERRED TO OPEN AIR ROCK EXCAVATION DURING THE OLD PANAMA COMPANY WORK, WITH MUCH LESS POWERFUL DREDGES THAN ARE NOW USED

"Anybody who has worked on the Isthmus with the two systems cannot but be struck with the enormous superiority of the dredge. It is so apparent, so obvious, that I did not hesitate at Culebra, as soon as the conditions became compatible with a dredging plant, to endeavor to substitute the work of the dredge to that of dry digging, and this in a hard clay that necessitated the employment of explosives for the work of excavating machines.

"Unfortunately, the plant was just in action when the collapse of the old company came; but however small has been its period of activity, perhaps a couple of months, the result completely confirmed my expectations and filled my hopes. Unfortunately for the canal, the inevitable and blind reaction which followed such a disaster as that of the Panama enterprise put into suspicion the clearest results obtained. I consider that it has been, among others, one of the most fatal mistakes of the New Panama Canal Company not to continue in the same line of effort.

"What they have done in the Culebra Cut would have been infinitely cheaper and quicker done if they had followed my last plans and not simply continued dry excavations, which I had put in action for a much longer period than the wet process.

"Since that time no more dredging has been done on the Isthmus, and therefore the truth has not been able to be again found and recognized.

"It can be stated with certainty from practical experience, such as the records of the Suez Canal may show, that under the very propitious conditions in which the excavation will be made on the Isthmus, without currents or without variation of water level, it can be made at a cost less than $1 per cubic yard, including repairs and depreciation of machinery. It can be equally stated from the same Suez Canal records that their rock may be extracted and dumped, including repairs and amortization of machinery, at a cost not reaching 75 cents a cubic yard. As for the hard clay, even with the light blasting it requires, the price ought to be kept below 30 cents a cubic yard with ordinary dredging and much reduced with electrical appliances, even including 12 cents for the amortization of the locks ascending to Lake Gamboa. The excavation of hard clay may be brought still lower with the new dredging apparatus resulting from the combination of cutters and suction pumps, but this is an eventuality of the future, and, though already resting on large experiments in Canada, it is not sufficiently proved adaptable to the isthmian ground to base reasonable and conservative estimates on, such as I give today.

"I have prepared the way for the employment of electricity in the working of the dredges, and I had built in Holland by Smulders an electric-driven dredge in 1895, according to special plans which I drew, and which was, so far as I know, the first electric dredge ever employed in public works. The results I obtained on the River Elsa, in

Spain, have been eminently satisfactory, and convinced me that thereby the dredge could acquire new qualities, reducing the expenses and the risk of accidents by unforeseen obstacles met under water."

ASTONISHING DECREASE OF THE PRICE OF EXCAVATION AND OF TRANSPORTATION

"Such a distribution of power under electrical form will practically leave on board the dredge but an insignificant number of men, and one may readily understand the extraordinary economy of such a system of excavation, producing 6,500 cubic yards in twenty-four hours with three shifts of 15 men, say with 45 men a day, even admitting the average abnormal price of $3 per man. The price of excavation proper will be reduced to $135 for 6,500 cubic yards, or about two cents a cubic yard, for the labor. This will be associated with a very reduced amount of expense for the repair of machinery, owing to the employment of electricity, and with no expense to speak of for the generation of power, which will be given by the fall of Gamboa Lake.

"The transportation would also be realized at a cost of perhaps one cent a cubic yard.

"The scows would have electric-driven screws and would take their power from a trolley line along the summit level and on the lake. One line would be for scows going to the dump and the other for scows returning. Assistance of tugs would only be required near the dredges, near the locks, and near the dumping places.

"I firmly believe that such a plant would reduce the price of excavation to a level difficult to believe.

"From every point of view, one must consider that the substitution of wet for dry excavation, if so understood, will create a veritable revolution in the prices and in the output of the work, owing to the great economy, efficiency, simplicity, and limitation of labor thus realized."

Mr Bunau-Varilla proposes that the sea-level canal when completed shall be 600 feet wide at the surface and 500 feet wide at the bottom and have a minimum depth of 45 feet at low tide. This would mean a canal three times wider and 10 feet deeper than the sea-level canal described on pages 462–464. He makes the further astounding claim that this immense sea-level canal by the process of dredging can be built in the same time required for the small sea-level canal (twenty-five years) if the latter is excavated by the dry process, and that the former will cost $300,000,000 as against $230,000,000 for the latter.

THE LABOR PROBLEM

The Isthmian Commission have now from 11,000 to 12,000 men at work, and of these 1,500 are Americans; 2,000 of the men are employed by the sanitary department, while the others are engaged in constructing sewerage and water systems, in building and repairing houses, in constructing tracks fo cars, and in getting everything ready for active digging of the canal. From 500 to 1,000 men are landing at the Isthmus each month seeking employment. They come from the West Indies principally, and a good number from Colombia.

Of the labor problem, Secretary of War Taft says in a recent report:

"The French Panama Company did much of its work with Jamaica negroes, and a large part of the 3,000 employés now engaged by the Commission is composed of Jamaicans; but it will not be easy to secure all the Jamaican laborers that will be needed. The governor of Jamaica, Sir Alexander Swettenham, whom I visited at Kingston, was unwilling to consent to our taking 10,000 laborers from the island unless we deposited five pounds sterling ($25) per

laborer with the island government to meet the burden which his leaving the island would probably throw on his parish under the poor law of the island for the support of those dependent on him. He also insisted that we should agree to pay the expenses of the return of each laborer, whether he was satisfactory or not and whether he abandoned the work in violation of his contract or not. It is probable, however, that Jamaica laborers will come voluntarily in considerable numbers to the Isthmus, because there are two direct lines between Kingston and Colon, the fare is only $5 a person, and the wages paid in the canal zone are double those paid in Jamaica. Indeed, the governor informed me that about 6,000 Jamaicans were leaving the island annually to work in Panama and Central America. It is hoped that satisfactory labor may be obtained in Porto Rico."

The labor problem will probably be harder to solve than any of the engineering difficulties.

THE STORMS AT COLON

In view of Admiral Chester's account of the destruction in Colon harbor caused by the terrible northers (p. 457), the following experience of the Isthmian Commission in January, 1905, is interesting:

The norther began blowing soon after noon of January 26 with such force that three steamships in the harbor of Colon at that time were compelled to seek safety by putting to sea and remaining away for three days. The U. S. Ship *Dixie* was preparing to leave at about that time and was obliged to hasten her departure to escape the danger of the storm. Not a vessel of any description remained in the harbor except two schooners in the slips adjacent to the Panama Railroad station, which were tied by a number of cables at a sufficient distance from their piers to prevent damage from excessive pitching and rolling. They could not get away, and were compelled to ride out in the gale in grave danger to themselves and to the neighboring piers.

At the time of the committee's visit storm waves of great magnitude and force were rolling directly into the harbor, breaking over the entire water front of that part of Colon known as Aspinwall and blocking the marginal streets with deluges of water and great quantities of coral rock and other débris. The same effects were produced on Christobal Point, seriously injuring a number of houses and rendering them uninhabitable, as well as putting out of use the marginal street. The magnitude and violence of the wave action along the entire water front of Colon not only drove to sea every vessel that could get away, but it also endangered the piers or wharves, some of which have been heretofore seriously damaged in similar storms. Further than this, great inconvenience and some loss was caused, not only to the shipping interests affected, but also to the canal work in interrupting the discharge of cargo urgently needed and in other ways injuring isthmian transportation.

These storms occur on the average but once or twice a year, and during some years they do not occur at all. For probably not less than three hundred and sixty days in the year the harbor of Colon is free from any objection of this kind. If the construction of the canal were a purely commercial enterprise, the protection of an outer terminal harbor open to storms at rare intervals, as in this instance, would not be justified. This project, however, is a great public work by the United States Government, in which no feature contributing effectively to either safety or efficiency should be omitted.

Plans and specifications are being prepared for a breakwater extending across the mouth of Limon Bay approximately on the line drawn from the light on

Toro Point to the Colon light. This breakwater will probably be designed in two parts, each about 4,000 feet long, with an opening between them 700 to 800 feet wide for the entrance of ships.

REMOVING SOURCES OF INFECTION

One of the most interesting features of the work has been the blood examinations to determine the malarial index of infection of the native population. About 80 per cent of the natives, says Colonel Gorgas, at the present time have the malarial parasite in their blood. Four times out of five when a female *Anopheles* bites one of the natives she becomes infected, and when she, in turn, bites one of our nearby laborers he becomes infected. It is thus evident that our force will rapidly be used up, just as was the French, unless our sanitary measures prevent it. There are two means of protection—quinine, which is harmless to man and fatal to the malarial parasite, and the destruction of the mosquito.

The following description of the cleaning of the town of Culebra is an instance of what is being done by our American sanitary corps throughout the canal zone:

The brush in the vicinity of the town has been removed and the streets, which are badly paved, are being kept clean. All manner of water containers were found buried under the brush, removed, and by removing the same the breeding places of the *stegomyia* were destroyed. The mosquito-proof water barrels have been regularly inspected and are in good condition. As a relatively large non-immune population live at Culebra, every effort is being made to stop the breeding of *stegomyia* in the vicinity. The garbage from each house is regularly removed, as well as the nightsoil from the pail closets that now exist. The surface drains are being kept in shape, and no mosquito larvæ are visible therein. All hogs have been removed from the town and all horses and cows are kept tied to stakes to prevent the ruination of the existing system of drainage.

THE MOSQUITO CAMPAIGN IN PANAMA CITY

Colonel W. C. Gorgas, Chief Sanitary Officer of the Isthmus, in his official report for July, 1905, describes the ceaseless fight waged by his corps against mosquitoes:

"The Administration Building in the city of Panama has been kept '*stegomyia* proof' during July. No eggs of *stegomyia* or other mosquitoes were found during the month, although all containers in this building, which is quite large, have been carefully and continuously scrutinized daily. This building is being fumigated every two weeks. After the two fumigations in July the floors were carefully swept and no mosquitoes were found, although the fumigations were strong enough to kill the flies which had entered the building. It takes a longer and stronger fumigation to kill flies than to destroy mosquitoes. There are about 400 employés, mostly non-immune Americans, in this building, who are specially anxious not to contract yellow fever, and it is reported by them that no mosquitoes are present. The building is undoubtedly a safe place at present for non-immunes.

"There is quite a noticeable decrease in the number of *stegomyia* present in Santa Ana Park since the same was trimmed out by this department in June. No cases of yellow fever or suspects were found in this vicinity during July, although it seemed to be a focus in previous months.

"The house-to-house inspection force has been increased, and some sections of the town are inspected every four days, and all houses and yards are inspected at least every six days.

"Whenever the inspector finds a water deposit containing mosquito larvæ the same is emptied out. Every

room of each house is carefully inspected for mosquito larvæ in water-containers placed therein. The work of the inspectors is also sufficiently checked, so that we know that the work is being properly and thoroughly done.

"During July, 1905, 5,189 house and yard inspections were made, and the mosquito larvæ (mostly in the early stages of development) were found in 579 of the houses inspected. By means of this continuous inspection at short intervals the mosquito larvæ are destroyed before they reach the pupal stage.

"The streets all over the city are being constantly torn up for the installation of the water and sewer systems. The rainy season is at hand, and so we have a collection of pools and water holes all over the city. A brigade of oilers is at work and these water surfaces are being kept covered with oil. The house-to-house inspection, combined with the work of the oil brigade, is giving good results."

SPLENDID RESULTS OF VIGILANCE

A comparison between the conditions that obtained during the first year of canal work under French administration and present conditions shows how successfully the United States is solving the question of sanitation. In 1881 the French reported an average force of 1928 men on the Isthmus, with a death rate of 66.8 per thousand, while in the Ancon hospital alone the deaths from yellow fever reached the proportion of 23.7 per thousand. In reassuring contrast to that record, the death rate on the canal zone among the 10,000 employés May, June, July (1905), was but 2.6 per thousand. This would make an annual mortality of about 10 per thousand. Of 12,000 men at work during August, 301 were constantly sick, or less than 25 per thousand.

The number of cases of fever, most of which recovered, decreased from 72 in June to 28 in July, due to the scientific efforts of the sanitary officers in screening, cleaning, draining, and taking all the other precautions that our Cuban victory over the fever has taught us to employ. It should be kept in mind that since De Lesseps' time science has solved the problem of checking yellow fever. The United States, therefore, has overcome what seemed to be to the French an unsurmountable obstacle.

PURE-WATER SYSTEM INAUGURATED

The marked decrease in the number of cases in what may be considered one of the worst months of the year is also due, in part, to the new water supply for the city of Panama that was first turned into the mains on July 4. With half pressure on a 6-inch main, 12 streams of water were thrown higher than the Administration Building, and this pure water is now turned in on several mains through the center of the city. Faucets have been attached to the hydrants and the people are now provided with free water. The advantages of this improvement can only be appreciated by those who are acquainted with the conditions that formerly obtained and can scarcely be overestimated. There was a celebration on the Fourth, and of course a game of baseball. The water supply for Colon and the sewerage systems of Panama City and Colon are rapidly nearing completion.

ARRANGEMENTS FOR THE COMFORT OF THE EMPLOYÉS

Another important change that will add to the health of the Isthmus is now well under way, and that is the establishment of comfortable quarters along the entire line of the canal, and by the end of the present month every non-immune employé can be comfortably lodged outside of Panama and Colon, which appear to be the only two foci of the diminishing fever on the Isthmus.

Plans are also under consideration

looking into the establishment of a refrigerating system, so that meat, vegetables, eggs, butter, poultry, and other foodstuffs can be brought from cold storage in the United States, transported in cold storage by vessels to the Isthmus, and then distributed by refrigerating cars to the ice-boxes of the hotels and boarding-houses along the line of the canal. With the installation of this service the personnel of the canal will be properly housed, will have pure water, will be well fed, and the question of proper sanitation will be solved.

The most efficient scientists and engineers are thoroughly convinced that eventually the Isthmus will be a pleasant and agreeable place of abode. They affirm that the fever is not indigenous to the Isthmus. The nights are cool and, with the exception of a short period in the middle of the day, the heat is not oppressive. Both Panama and Colon can be rendered as agreeable places of residence as Mobile or Pensacola.

The Commission have about twelve American steam shovels at work; others are arriving at the rate of about two a month.

The Isthmian Commission found that their employés were not being properly fed; local merchants lacked capacity or enterprise to provide for so many newcomers; prices for food had nearly doubled in the past two years, with the result that the employés had great difficulty in securing sufficient food of the right quality. In view of this fact, the Commission have made arrangements with an American firm to supply the employés of the company with wholesome food at rates varying from about $10 to $30 a month. The rations must reach a standard set by the Commission, which will inspect the food.

G. H. G.

THE GREAT CANALS OF THE WORLD*

THE Suez Canal is usually considered the most important example of ship canals, though the number of vessels passing through it annually does not equal that passing through the canals connecting Lake Superior with the chain of Great Lakes at the south. In length, however, it exceeds any of the other great ship canals, its total length being 90 miles, of which about two-thirds is through shallow lakes. The material excavated was usually sand, though in some cases strata of solid rock from 2 to 3 feet in thickness were encountered. The total excavation was about 80,000,000 cubic yards under the original plan, which gave a depth of 25 feet. In 1895 the canal was so enlarged as to give a depth of 31 feet, a width at the bottom of 108 feet and at the surface of 420 feet. The original cost was $95,000,000, and for the canal in its present form slightly in excess of $100,000,000. The number of vessels passing through the canal in 1870 was 486, with a gross tonnage of 654,915 tons; in 1875, 1,494 vessels, gross tonnage, 2,940,708 tons; in 1880, 2,026 vessels, gross tonnage, 4,344,519 tons; in 1890, 3,389 vessels, gross tonnage, 9,749,129 tons; in 1895, 3,434 vessels, gross tonnage, 11,833,637 tons; and in 1900, 3,441 vessels, with a gross tonnage of 13,699,237 tons. The net profits of the canal for 1903 were 65,579,347 francs ($12,500,000) and the stockholders received dividends of 12 per cent.

The canal is without locks, being at the sea level the entire distance. The length of time occupied in passing

* The facts in this article are derived from an exceedingly instructive monograph published (1905) by the Bureau of Statistics of the Department of Commerce and Labor, entitled "The Great Canals of the World," by O. P. Austin.

through the canal averages about eighteen hours. By the use of electric lights throughout the entire length of the canal, passages are made at night with nearly equal facility to that of the day. The tolls charged are 9 francs per ton net register, "Danube measurement," which amounts to slightly more than $2 per ton, United States net measurement. Steam vessels passing through the canal are propelled by their own power.

THE CRONSTADT AND ST PETERSBURG CANAL

The canal connecting the Bay of Cronstadt with St Petersburg is described as a work of great strategic and commercial importance to Russia. The canal and sailing course in the Bay of Cronstadt are about 16 miles long, the canal proper being about 6 miles and the bay channel about 10 miles, and they together extend from Cronstadt, on the Gulf of Finland, to St Petersburg. The canal was opened in 1890 with a navigable depth of 20½ feet, the original depth having been about 9 feet; the width ranges from 220 to 350 feet. The total cost is estimated at about $10,000,000.

THE CORINTH CANAL

The next of the great ship canals connecting bodies of salt water in the order of date of construction is the Corinth Canal, which connects the Gulf of Corinth with the Gulf of Ægina. The canal reduces the distance from Adriatic ports about 175 miles and from Mediterranean ports about 100 miles. Its length is about 4 miles, a part of which was cut through granitic soft rock and the remainder through soil. There are no locks, as is also the case in both the Suez and Cronstadt Canals, already described. The width of the canal is 72 feet at bottom and the depth 26¼ feet. The work was begun in 1884 and completed in 1893, at a cost of about $5,000,000. The average tolls are 18 cents per ton and 20 cents per passenger.

THE MANCHESTER SHIP CANAL

The Manchester Ship Canal, which connects Manchester, England, with the Mersey River, Liverpool, and the Atlantic Ocean, was opened for traffic January 1, 1894. The length of the canal is 35½ miles, the total rise from the water level to Manchester being 60 feet, which is divided between four sets of locks, giving an average to each of 15 feet. The minimum width is 120 feet at the bottom and averages 175 feet at the water level, though in places the width is extended to 230 feet. The minimum depth is 26 feet, and the time required for navigating the canal from five to eight hours. The total amount of excavation in the canal and docks was about 45,000,000 cubic yards, of which about one-fourth was sandstone rock. The lock gates are operated by hydraulic power; railways and bridges crossing the route of the canal have been raised to give a height of 75 feet to vessels traversing the canal, and an ordinary canal whose route it crosses is carried across by a springing aqueduct composed of an iron caisson resting upon a pivot pier. The total cost of the canal is given at $75,000,000. The revenue in 1901, according to the Statesman's Yearbook, was £621,128, and the working expenses, £483,267. For the year ending June 30, 1903, the canal yielded £55,105 ($275,525) toward paying the £225,000 ($1,125,000) of interest which the city of Manchester has to pay on the capital invested in the enterprise. The freight-paying tolls on the canal are increasing each year.

THE KAISER WILHELM CANAL

Two canals connect the Baltic and North seas through Germany—the first, known as the Kaiser Wilhelm Canal, having been completed in 1895 and constructed largely for military and naval purposes, but proving also of great value to general mercantile traffic. Work upon the Kaiser Wilhelm Canal was

begun in 1887 and completed, as above indicated, in 1895. The length of the canal is 61 miles, the terminus in the Baltic Sea being at the harbor of Kiel. The depth is 29½ feet, the width at the bottom 72 feet, and the minimum width at the surface 190 feet. The route lies chiefly through marshes and shallow lakes and along river valleys. The total excavation amounted to about 100,000,000 cubic yards, and the cost to about $40,000,000. The number of vessels passing through the canal in 1904 was 32,038, with a tonnage of 4,990,287, and the dues collected amounted to about $580,000.

SHIP CANALS CONNECTING THE GREAT LAKES OF NORTH AMERICA

Three ship canals intended to give continuous passage to vessels from the head of Lake Superior to Lake Ontario and the St Lawrence River are the Welland Canal, originally constructed in 1833 and enlarged in 1871 and 1900; the St Marys Falls Canal at Sault Ste. Marie, Mich., opened in 1855 and enlarged in 1881 and 1896, and the Canadian Canal at St Marys River, opened in 1895. In point of importance, measured at least by their present use, the canals at the St Marys River by far surpass that of the Welland Canal, the number of vessels passing through the canals at the St Marys River being eight times as great as the number passing through the Welland, and the tonnage of the former nearly forty times as great as that of the latter. One of the important products of the Lake Superior region, iron ore, is chiefly used in the section contiguous to Lake Erie, and a large proportion of the grain coming from Lake Superior passes from Buffalo to the Atlantic coast by way of the Erie Canal and railroads centering at Buffalo. The most important article in the westward shipments through the Sault Ste. Marie canals, coal, originates in the territory contiguous to Lake Erie. These conditions largely account for the fact that the number and tonnage of vessels passing the St Marys River canals so greatly exceed those of the Welland Canal.

The Welland Canal.—The Welland Canal connects Lake Ontario and Lake Erie on the Canadian side of the river. It was constructed in 1833 and enlarged in 1871 and again in 1900. The length of the canal is 27 miles, the number of locks 25, the total rise of lockage 327 feet, and the total cost about $25,000,000. The annual collection of tolls on freight, passengers, and vessels averages about $225,000 and the canal is open on an average about two hundred and forty days in a year.

The Sault Ste. Marie Canals.—The canals of Sault Ste. Marie, Mich., and Ontario are located adjacent to the falls of the St Marys River, which connect Lake Superior with Lake Huron and lower or raise vessels from one level to the other a height of 17 to 20 feet. The canal belonging to the United States was begun in 1853 by the state of Michigan and opened in 1855, the length of the canal being 5,674 feet, and provided with two tandem locks, each being 350 feet in length and 70 feet wide and allowing passage of vessels drawing 12 feet, the original cost being $1,000,000. The United States government, by consent of the state, began in 1870 to enlarge the canal, and by 1881 had increased its length to 1.6 miles, its width to an average of 160 feet, and its depth to 16 feet; also had built a single lock 515 feet long and 80 feet wide, with a depth of 17 feet on the sills, which was located 100 feet south of the state locks. The state relinquished all control of the canal in March, 1882. In 1887 the state locks were torn down and replaced by a single lock 800 feet long, 100 feet wide, and a depth of 22 feet of water on the sills. This lock was put in commission in 1896. The canal was also deepened to 25 feet. The Canadian Canal, 1⅛ miles long, 150 feet wide, and 22 feet deep,

with lock 900 feet long, 60 feet wide, with 22 feet on the miter sills, was built on the north side of the river during the years 1888 to 1895.

The number of vessels passing through the United States canal in 1902 was 17,588, and through the Canadian canal 4,204. In 1900 the number of vessels passing through the United States canal was 16,144, and through the Canadian canal 3,003, showing an increase of 1,200 in the number of vessels passing through the Canadian canal, and a slight decrease in the number through the United States canal, the increase in the number passing through the Canadian canal having been due to the development of the Michipicoten district. The tonnage passing through the United States canal in 1902 was: Registered tonnage, 27,408,021 tons; in 1901, 22,222,334 tons, against 20,136,782 in the year 1900; the freight tonnage in 1901 was 25,026,522 tons, against 23,251,539 tons in 1900. The Canadian Canal shows: Registered tonnage in 1902, 4,547,561; in 1901, 2,404,642 tons, against 2,160,490 in 1900. A marked contrast between the business of the St Marys Falls and Welland canals is found in a comparison of their figures for a term of years. The number of vessels passing through the Welland Canal in 1873 was 6,425, and in 1899, 2,202, a reduction of more than one-half in the number of vessels. The number of vessels passing through the St Marys Falls Canal in 1873 was 2,517, and in 1902, through the American and Canadian canals, 22,659.

THE CHICAGO SANITARY AND SHIP CANAL

The Chicago Sanitary and Ship Canal connects Lake Michigan at Chicago with the Illinois River at Lockport, a distance of 34 miles. The canal was cut for the purpose of giving to the city of Chicago proper drainage facilities by reversing the movement of water, which formerly flowed into Lake Michigan through the Chicago River, and turning a current from Lake Michigan through the Chicago River to the Illinois River at Lockport, and thence down the Illinois River to the Mississippi. The minimum depth of the canal is 22 feet, its width at the bottom 160 feet, and the width at the top from 162 to 290 feet, according to the class of material through which it is cut. The work was begun September 3, 1892, and completed and the water turned into the channel January 2, 1900. The flow of water from Lake Michigan toward the Gulf is now at the rate of 360,000 cubic feet per minute, and the channel is estimated to be capable of carrying nearly twice that amount. The total excavation in its construction included 28,500,000 cubic yards of glacial drift and 12,910,000 cubic yards of solid rock, an aggregate of 41,410,000 cubic yards. In addition to this, the construction of a new channel for the Desplaines River became necessary in order to permit the canal to follow the bed of that river, and the material excavated in that work amounted to 2,068,659 cubic yards, making a grand total displacement in the work of 43,478,659 cubic yards of material, which, according to a statement issued by the trustees of the sanitary district of Chicago, would, if deposited in Lake Michigan in 40 feet of water, form an island one mile square with its surface 12 feet above the water line.

All bridges along the canal are movable structures. The total cost of construction, including interest account, aggregated $34,000,000, of which $21,379,675 was for excavation and about $3,000,000 for rights of way and $4,000,000 for building railroad and highway bridges over the canal. The city and state authorities, by whom the canal was constructed, are now proposing to Congress to make this canal a commercial highway in case Congress will increase the depth of the Illinois and Mississippi rivers to a depth of 14

feet, with locks for fleets of barges from Lockport, the terminus of the drainage canal, to St Louis. This, it is argued, would give through water transportation from Lake Michigan to the Gulf by way of the drainage canal, the Illinois River, and the Mississippi River, and would enable the United States, in case of war, to quickly transport light-draft war vessels from the Gulf to the Lakes. This work of deepening the Illinois River would also give through water connection from Rock Island, on the upper Mississippi River, to Lake Michigan via the Illinois and Mississippi Canal, elsewhere described, which extends from Rock Island, on the Mississippi River, to Hennepin, on the Illinois River. The estimate of the Chicago sanitary district trustees of the cost of deepening the Illinois and Mississippi rivers from the terminus of the ship canal to St Louis to a depth of 14 feet is $25,000,000, including five locks and dams.

THE PEACE OF LATIN AMERICA*

NEARLY three-fifths of the 15,000,000 square miles of the Western Hemisphere is covered by the twenty different nations which are broadly included in the term Latin America. All these nations are republics, in name at least. It may be a mere coincidence or it may be a fact of profound importance, that during the current year the entire area has been practically free from revolution. It is doubtful if the experience of the last eighty years can duplicate the present situation.

We are inclined to regard this as something more than a coincidence. We believe it to be significant, a sign of political development and a proof of increasing stability. We do not attribute the condition to a fear of the "big stick" or to an apprehension of any broadening of the "corollary of the Monroe Doctrine." It is more probable that it is due to two well-defined though little recognized influences. One of these is the force of example, notably that of Mexico. The other is the extension of industry and commerce. There is in all these lands a growing recognition of the fact that revolutions are unprofitable. With the great mass of the people the idea is probably subconscious, but we believe it is there, and that it is busily working out a destiny of peace for our Latin American neighbors.

A Colombian writer, Señor Enrique Perez, recently made an admirable statement of the case for the Latin Americans. He says:

"It should be borne in mind by those who are always ready to pass criticisms on South American affairs that not all nations have had at their disposal the means of improving their conditions which, by a chain of exceptionable circumstances, it has been given to the United States to profit by. Civilization was not carried from Spain to South America, as to a certain extent it may be said that it was transferred from all European countries to the United States.

"The South American countries did not have the same happy chances. The greed for gold and the race for El Dorado were the main inducements of the Spaniards who, at the peril of their lives, crossed the ocean in unfit vessels in a mad pursuit after the gold and all other precious property of the Indians. The Spanish conquerors did not teach the natives, outside of religion, any of the practical methods of life, or rather those considered practical in those days.

"After the conquest was accomplished there came a period, covering three centuries, during which nothing was done by Spain to better the condition of those countries."

This is an interesting and a precise statement of the case. From California to the Southern Andes and from Carta-

* From the New York Sun.

gena to the Rio de la Plata, the country now known as Latin America was seized by men whose purpose was to find gold, or in other ways to acquire wealth quickly and easily. Simon Bolivar, about 1820, was perhaps the first man who really saw the matter in its broader light. The history of the federation which he established has been in general the history of the entire region. It was an effort to plant a new civilization among a people imperfectly prepared for it.

To those who settled on the coast of what is now the United States the terms freedom and self-government had a definite meaning. The motives which led them to seek homes in the new world were widely different from those which impelled the gold-seekers and the conquistadores who landed further south. Any similarity in the later political structures was impossible.

Signs of development in the southern countries can be traced for somewhat more than fifty years. During the last twenty years the signs have become ever increasingly marked. Mexico, Chile, Peru, Brazil, and Argentina are no longer to be classed among the turbulent.

An ambition for progress and political stability is noticeable in nearly all, if not in all, of the remaining peoples. The people of Cuba, of Guatemala, Costa Rica, and Nicaragua resent the charge or the insinuation that they are hotbeds of revolution. They pride themselves on every added year of domestic peace. Colombia aspires to repeat the experience of Mexico. Cipriano Castro, today almost unique, is a survival of the despot who ruled the peon a century ago, and even in his case the type is essentially modified.

It is perhaps too much to expect that this peace of months will expand itself into a peace of years; but the situation is noteworthy, and we believe it to be deeply significant.

FORESTRY IN CALIFORNIA

CALIFORNIA has over 28,000,000 acres, or over one-fifth of its total area, under forest cover. Much of this land is finely timbered, and, with forest management, will be increasingly valuable for the wood which it can supply. But in California the forests have another use, which, as is well understood in that state, is even more important than the production of timber—to conserve the water supply. The wonderful agricultural development which irrigation has made possible is perhaps the largest fact in California's recent economical history. Because of the need of water and the fear of floods, public sentiment in favor of forest protection in California has always been well in advance of that in other states, as was conspicuously illustrated after President Cleveland, in 1897, proclaimed the 13 Federal reserves, created at the close of his administration. Everywhere else in the West the opposition aroused was so strong that the proclamation was soon afterward temporarily suspended; but a special exception was made in the case of California, where public opinion was from the first strongly in favor of the reserves.

Something less than one-third of the entire wooded area of the state is now embraced in the Federal forest reserves. That the remaining 20,000,000 acres of its forests may be made to serve the public interest in the fullest possible measure, the state has solicited and secured the coöperation of the Forest Service in working out a proper forest policy for it.

But the subject of paramount importance is the prevention and control of fires. A good opportunity for experiment along this line was afforded the service by coöperation with the private owner of an 80,000-acre tract, who had previously introduced a crude fire-protection system. A comprehensive plan

was outlined and its execution begun. There has not been time for a thorough trial, but its installation has had an excellent effect. The patrolling of the tract has been greatly improved, and the neighbors now voluntarily report all fires, whether on or off the tract. There has not been a serious fire on that tract this season. This splendid showing is an impressive object lesson. It proves the efficiency of intelligent care and of fighting fires at the start. The present fire laws of the state are incomplete and inadequate. One result of the work of the Service will be the recommendation of a fire law which, if adopted, will be the best ever passed by any state.

The most encouraging fact in forest management is the growing determination of large timberland owners to employ private foresters to handle their holdings. This will ensure a method of lumbering less wasteful than that at present practiced, and, more important by far, it will be the means of better protecting the forests and making them yield a continuous crop. Such expert control will be especially valuable in solving the problem of the best way to get rid of the slash, which, until burned, is a constant menace to the forests. Extensive experiments in slash burning have already been carried on by the Service with satisfactory results.

The study of chaparral has led to fruitful practical conclusions. It shows in California the same remarkable ability to encroach upon and spread over open country that it exhibits in Texas and elsewhere in the semi-arid portions of the southwest. It makes a satisfactory watershed cover and almost constantly replaces a forest destroyed by fire. Its composition varies with aspect and elevation and with damage by fire.

CHINESE LABOR FOR MEXICO

UNITED States Consul Anderson, of Amoy, China, reports that the owners of certain plantations in Mexico, especially in Yucatan, seem to be making an effort to secure Chinese labor for their establishments. According to an advertisement in a native paper, the Japanese now have charge of the work of enlisting men in this proposed agricultural army. The advertisement, as translated, says, among other things:

"About a year ago a certain agricultural concern in Mexico sent a special agent to Fuchau for the purpose of securing Chinese laborers, such laborers to take their families with them if necessary. They were to be shipped to Mexico to work on hemp plantations, but to do no other work. This enterprise had the consent of the governor of Yucatan, Mexico, but owing to the ignorance of Chinese law on the part of the agent, he undertook to issue an official proclamation himself, and consequently his mission was brought to a sudden end by the order of the Mexican consul. The agriculturists of Mexico need labor just as badly now as a year ago, and have applied to the Cho Kiu Kan, emigration agents of Japan, for assistance. . . . Everything set forth in this notice is entitled to confidence. Incidentally, it may be added that the treaty concluded between China and Mexico provides for the free emigration of citizens of either country and for the mutual protection of such emigrants. Emigrants take no risk whatever. It is understood that the foreign office in Fuchau has issued a proclamation on the subject, publishing all treaties and regulations relating thereto."

The response to this proposition does not seem to have been as general from any part of this province as was hoped, but it is probable that it will be general enough to make up a fair-sized shipment of coolies to Mexican territory. Not less than 2,500,000 people from the Amoy district are abroad in such enterprises.

The number of Chinese emigrants leaving Amoy this year seems to be about the same as usual. Something

like 75,000 will go to Singapore and the Straits Settlements and between 5,000 and 6,000 to the Philippines. Ten thousand will probably go to Hongkong, Saigon, and other ports. The money sent home by these emigrants is by far the largest financial resource of the people of this district.

POLAR EXPLORATION

THE year 1905–1906 will be the quietest, as far as polar work is concerned, known for some time. Only two expeditions, those of Commander Peary and the Amundsen Magnetic Expedition, are now in the Arctics, none are in the Antarctics, and no others are planned against either Pole.

The latest word from Commander Peary comes by Dr Frederick Sohon of Washington, D. C., who left Etah, Greenland, the last week in August. He reports that the *Roosevelt*, Peary's ship, left Etah steaming north on August 20. Nothing but open water could then be seen toward the north, or when Dr Sohon left several days later. Apparently conditions were very favorable for Commander Peary and it is generally believed that he succeeded in taking his ship at least as far as the entrance of Kennedy Channel. This point is considerably farther north than he has succeeded in getting his supply ship before, which means that his base will be so much nearer the Pole. The *Roosevelt* carried from Etah 68 Eskimo men, women, and children and 250 dogs. Commander Peary will distribute them in stations along the coast.

THE POPULATION OF JAPAN

ACCORDING to the last official Japanese census, the population of Japan had grown from 41,388,313 in 1893 to 46,732,841 in 1903, an increase of 5,344,528 in ten years. This is exclusive of Taiwan (Formosa), which in 1902 had a population of 3,000,111. In round figures the population of the Empire of Japan may be stated at 50,000,000.

Except in the acquirement of Formosa in 1895, there has not been any sudden increase in Japan's population, but a steady increase year after year, beginning with 423,902 in 1894 and closing (for this computation) with 710,332 in 1903, an average increase of 534,000 for each of the ten years.

The 1903 population of Japan proper, namely, 46,732,841, consisted of 23,605,571 males and 23,131,270 females. This equality of the sexes is noticeable, especially as it has continued through all of the ten years.

The population of Taiwan (Formosa), 3,000,111, has grown at the rate of from 68,000 to 84,000 a year since 1898. In 1902 it consisted of 2,953,034 natives and 47,077 Japanese. In 1898 the Japanese in the island numbered 25,585.

The number of deaths in Japan proper was 937,644 in 1893 and 952,252 in 1903, the figures for each of the ten years being nearly the same. It was not so with the yearly births. They were 1,178,428 in 1893 and steadily increased each year, reaching 1,493,599 in 1903. Here we see the necessity for Japan's expansion into Korea. Japan's area is limited and only 12 per cent of it is arable land; consequently providing for 534,000 increase in population each year was a most serious question. That point is settled now, and the Japanese are flocking into Korea.

In the ten years the average marriages per 1,000 of the population of Japan have been 8.71. Divorces averaged 9,400 a year, or 2.13 per 1,000 marriages. That is certainly a low divorce rate for an oriental country.

In 1903 the ratio of urban population was 20 per cent, an increase of 7.5 per cent since 1896, and of suburban 80 per cent, a decrease of 7.5 per cent.

In the seventeen years, 1886-1903, the urban population increased by 4,448,656, and the suburban by 3,215,494. Thus Japan has the American problem to deal with—the overcrowding of people into the cities. WALTER J. BALLARD.

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